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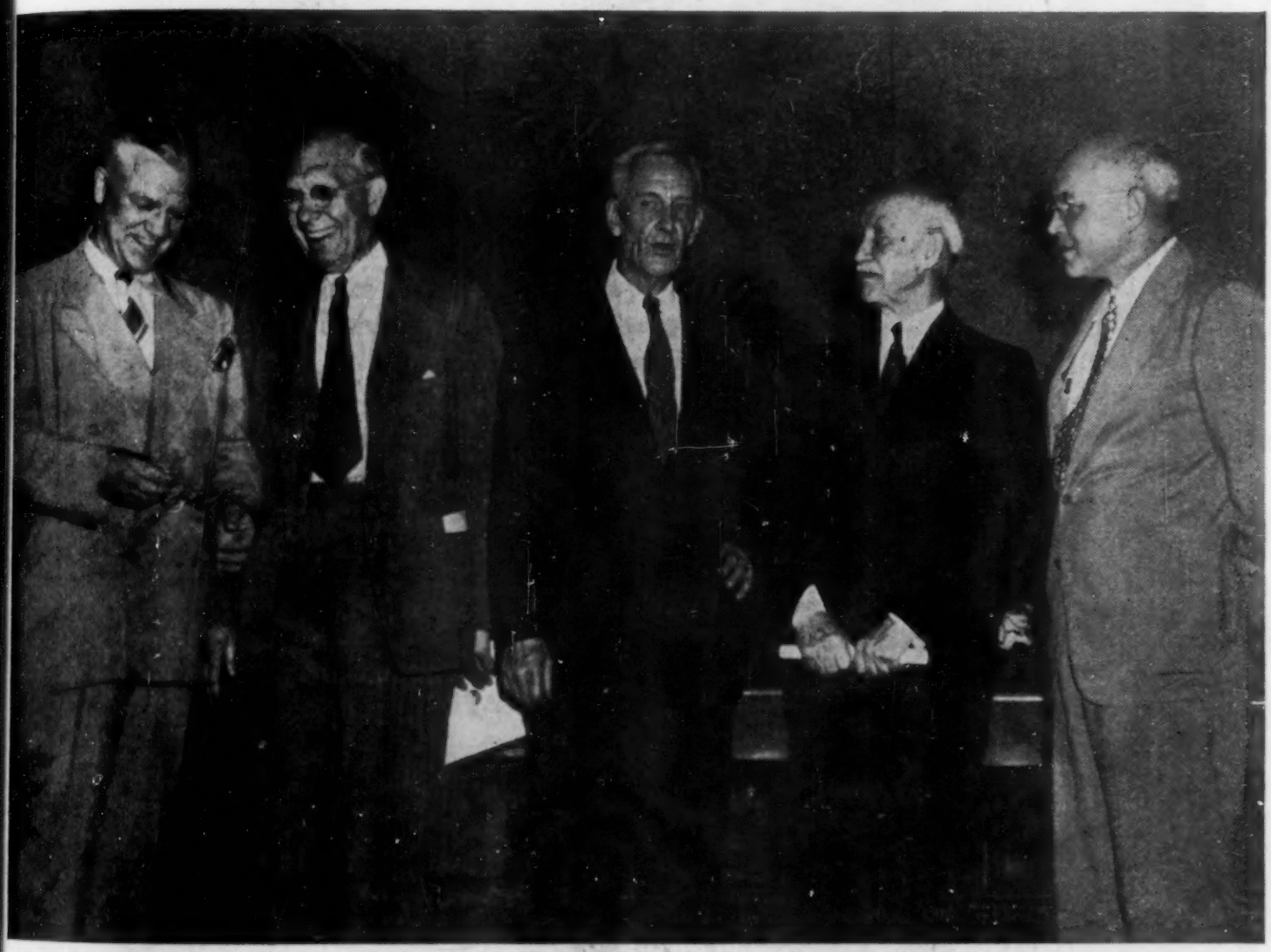

Pictured at the Centennial Anniversary Celebration of Earlham College, Richmond, Indiana, September 19–23, are: (*left to right*) Thomas E. Jones, president of the College; Charles F. Kettering, General Motors Corporation; Walter R. Miles, Yale University; Orville Wright, Dayton, Ohio; and Wendell M. Stanley, Rockefeller Institute for Medical Research (see *News and Notes*).

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The Nucleus in Relation to Heredity and Sex

Edward C. Jeffrey

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The Nucleus in Relation to Heredity and Sex

Edward C. Jeffrey

The Biological Laboratories, Harvard University

THE NUCLEUS OF THE LIVING CELL IN plants and animals has a most important relation to its activities and functions. It is clear, from the study of cells deprived of their nuclei in a way not to injure the body or cytoplasm of the cell, that the nucleus presides over its fundamental activities, such as growth, elaboration and use of foodstuffs, formation of new cells, and, finally—most important of all—over reproduction. It may, in fact, be stated that the nucleus of the cell in living organisms plays a role comparable to that shown in recent years to be enacted by the nucleus of the atom in the inorganic world.

Only slightly more than a quarter of a century ago, the genius of Rutherford revealed for the first time the nature of the atom and its all-important nucleus. With his truly epoch-making discovery, science passed from the era of the atom as a hypothetical "vortex ring" in an equally hypothetical "ether." Although the students of living matter have not been so frustrated by the exceedingly minute as have the physicists and chemists in the case of the atom, the living cell and its all-important nucleus require for their adequate investigation the highest powers of the microscope.

Equally important for the study of the living cell is the art of instantaneous fixation, at given moments, of its numberless activities. This is comparable to the study of the flight of bullets or similarly rapid movements by the instantaneous camera. Until relatively recently the student of the living cell has had to depend on somewhat slowly-acting preservatives dissolved in, or diluted by, water. The generalizations of cytology, or the science of the minute structure of the cell and its constituent parts, are based on preservative solutions in water of osmic acid, chromic acid, and various combinations of these with one another and with other reagents, as well as organic preservatives such as formaline, etc. These solutions penetrate too slowly to preserve accurately and instantaneously the organization of the fundamental structures of chromosomes at a given moment. We owe to a Beligan biologist (Carnoy) the earliest invention of reliable reagents causing instantaneous death or fixation. These fluids, variously formulated, depend for their rapid and instantaneous action on that extremely penetrating reagent, 100 per cent, or so-called absolute, alcohol. The shrinkage caused by this powerful reagent is controlled by the appropriate addition of a powerful swelling reagent, glacial acetic acid. These two, sometimes with the addition of other substances, for the first time gave us some accurate insight into the organization of the nucleus of the cell, in its active or kinetic stages. As a result of the improvement of Carnoy's procedures by various modifications, we are now in position to undertake at least the beginning of a recording of the structure and activities of the all-important active or kinetic nucleus of the living cell. The knowledge thus obtained appears to make necessary a fundamental revision of the "cell doctrine," particularly so far as the nucleus is concerned.

This is an objectively illustrated, general account of fundamental investigations on chromosomes, which appear to render necessary a revision of our views regarding the relation of the nucleus and its derivative chromosomes to heredity and the determination of sex.

The resting or quiescent nucleus is still relatively a closed book to the cytologist, on account of its extremely minute organization. The active or kinetic nucleus, however, presents structures, chromosomes, which are more easily resolved by our existing visual microscopes; unfortunately, the extreme magnifications supplied by the electron microscope are largely discounted by its very definite limitations in the investigation of active living matter. The relatively low magnifying power of our visual microscopes has limited cytologists in their studies to the examination of the largest available chromosomes of the active nucleus. These are found in the initial stages of reproduction. When a nucleus passes into the active or kinetic stage, it is resolved into a number of units, the chromosomes, which are definite in number in any given case. It was observed in the final decades of the 19th Century that the chromosomes in the active or dividing stages of the body cells were twice as numerous as in the case of the cells concerned in reproduction. It was further clear that when living beings, whether plants or animals, reach sexual maturity, a reduction from the double somatic number to the single reproductive number takes place. This was designated by an English biologist (Farmer) as meiosis, the Greek equivalent of reduction. The fact that the meiotic or reductive chromosomes achieve their halved number by taking on a double size made them particularly favorable, in comparison with other chromosomes, for study with the relatively feeble powers of existing visual microscopes. A further incentive to their study has been supplied by their relation to reproduction, for it has very naturally been believed that a study of the chromosomes on the brink, as it were, of reproduction might throw a revealing light on the process of reproduction itself.

As a result of their large size, which made them favorable objects for microscopic study, the meiotic chromosomes constituting the transition from the double or

bodily (somatic) number of chromosomes to the single or reproductive (gametic) have been practically the entire basis of our knowledge of chromosomal structure, to the almost complete exclusion of other equally or even more important types.

Another important limitation of our knowledge of the organization of chromosomes has arisen from the idea that the reduction in chromosomal number in the meiotic stage was merely the result of the fusion of the chromosomes side by side in pairs as reduction or meiosis took place, technically known as synapsis or syndesis. This assumption is the result of a palpable disregard of the structure of the somatic or bodily chromosomes and, above all, of the organization of the hitherto completely structurally unknown reproductive or gametic chromosomes. In the actual state of our knowledge there is no authentic case of the union of chromosomes side by side, for a study of the organization of all types of chromosomes shows clearly that chromosomes become united invariably only end to end. Moreover, the union of chromosomes never takes place at the beginning of a nuclear division (as is assumed in current speculations as to the nature of meiosis or reduction), but at the end (telophase) of the immediately preceding division. It may be added that not only is the union of chromosomes in cell division characteristic of, and confined to, the end of the preceding division, but this situation is likewise an unfailing feature of all chromosomal unions, whether somatic, reproductive, or reductional.

The Structure of Chromosomes

Obviously, since chromosomes are an important and apparently a primitive feature of all nuclear division in the higher plants and animals, a knowledge of their intimate organization is absolutely necessary for an understanding of their relationship to hereditary transmission and the determination of sex. This is essential not only because of the fundamental importance of structure in this connection, but because general ignorance on this subject is unfortunately universally prevalent. Such information as is available on the true situation in this respect has appeared in foreign journals not usually accessible at this time to American cytologists. Further, since information supplied appears as yet to be regarded with general skepticism, a necessarily limited amount of objective evidence in the form of photomicrographs under high magnification is supplied in the present connection.

Fig. 1 represents the anaphase, or advanced stage of nuclear division, in the body cells of the root in the liliaceous genus, *Trillium*, characterized by the especially large size of its chromosomes, which makes them particularly favorable for investigation. The chromosomes are arranged in the two daughter groups characteristic of this stage. If the individual chromosomes are examined, it becomes obvious that they have a complex organization, consisting of a double spiral in which the coils (gyres) cross one another at somewhat regular intervals. This is particularly well seen in chromosomes in the upper left of the illustration. Similar organization has been universally described in large chromosomes of the meiotic division and has been generally regarded as an exclusive characteristic and most significant feature of this division. It has, moreover, been interpreted as representing the union of pairs of chromosomes derived from the parental egg and sperm. Since the condition now appears to be universally present in the somatic nuclear divisions, that interpretation obviously can no longer be logically accepted.

Fig. 1. Anaphase of a somatic division in *Trillium* (× 4,000).

Fig. 2 illustrates objectively in a photomicrograph a somatic division from a root of the common spiderlily, *Tradescantia*. The same complex and double structure can be clearly seen in such of the chromosomes as appear in sharp focus under the very high magnification shown.

Fig. 3 reproduces a comparable stage of division of the nucleus in the developing pollen grain of *Tradescantia*. The upper part of the dividing figure shows chromosomes evidencing the same double, crossing, spiral coils as are seen in the preceding two figures. It is thus objectively

ear that all chromosomes have the same and identical tructure and all are characterized by the presence of two piral coils of chromatin (variously known in cytological

FIG. 2. Anaphase of a somatic division in *Tradescantia* (× 5,000).

iterature as chromatids or chromonemata). The double chromosomal coiled structure is, accordingly, not confined o the meiotic, or reductional, chromosomes appearing at exual maturity, as has been practically universally as-umed in the genetical literature of the present time.

FIG. 3. Reproductive division in the young pollen grain of *Tradescantia* (× 5,000).

Further, if the dual structure of the meiotic divisions marking the advent of the sexual cells or gametes were to be interpreted (as is generally accepted) as the result of the fusion of the double somatic equipment of chromosomes in homologous pairs of opposite sex, a *reductio ad absurdum* is reached, since meiotic, somatic, and gametic chromosomes all exhibit identically the same organization.

Fig. 4 shows a summary and slightly diagrammatic illustration of the situation described above in *Tradescantia*. In *a* appears a side view of the chromosomes at a late stage of nuclear division in a body or somatic cell. The double chromatin spirals can be easily distinguished. A comparable stage from the dividing gametic, or reproductive, nucleus of the pollen grain is shown in *b*. In *c* appears a division from the food substance, or endosperm, of the developing seed, which likewise shows identical features of chromosomal organization. In the three figures are represented side by side chromosomes of three distinct and typical categories, which, nevertheless, show identical internal organization. An earlier stage of division in the meiotic nucleus is illustrated in *d*. Here the chromosomes have become clearly doubled as a preliminary to division of the cell. The same stage in a gametic division in the young pollen grain may be seen in *e*. In *f* is shown a lateral view of the meiotic or reductional division. Ob-

FIG. 4. Drawings of various types and stages of chromosomes in *Tradescantia*.

viously, in all these varied types of chromosomes the internal organization is identical. This situation, as has been shown objectively above by photomicrographs, is entirely unfavorable to the current views regarding the relation of chromosomes to inheritance.

The present writer has previously pointed out in *Science* (*1*), on the basis of the facts of fertilization, as revealed by improved technique, that the chromosomes present in the fusing gametes, sperm and egg, as well as in the divisions of the fertilized egg itself, are identical in organization. It follows that the doctrine of the side-by-side, or lateral, fusion of chromosomes in the reduction division and the conclusions in regard to hereditary transmission based on that supposed condition have no sound basis in fact.

This situation eliminates also the contradiction that the reductional division preceding the formation of the gametes, in contrast to all other typical nuclear divisions, involves a fusion rather than a division of chromosomes.

There is a further important and, indeed, fundamental conclusion of current cytogenetics, negatived by the facts derived from the objective study of chromosomes by the improved and revealing methods outlined in an earlier paragraph. It has been assumed for several decades that the determination of sex may be brought about by male- and female-producing sex chromosomes, usually designated X and Y chromosomes. These are supposed to make their appearance in the meiotic stage and to persist throughout the somatic or body cell divisions. They have also been described and figured in the somatic divisions of *Drosophila* and other dipterous insects. The present writer has called attention to the erroneousness of this conclusion in such relatively favorable dipterous species as the mosquito (*Culex*) and the blackfly (*Simulium*) (*1*). This fallacy is obvious from a study of the course of chromosomal division in the cells of the body in the two-winged flies or Diptera, which makes it clear that the so-called sex chromosomes originate by division from the same mother chromosomes, exactly as is the case with the other chromosomes of the body. They are thus of identical origin and organization and consequently cannot be in any sense regarded as sex determinants.

The recent course of cytological investigation appears to make it clear that, as in the inorganic world, fundamental characters are concealed in atomic and molecular structures beyond the range of vision of our present visual and even electronic microscopes.

It may also be added that the supposed genes revealed in imperfectly preserved, reproductive chromosomes are merely the crossing points of the double spirals of chromatin, present in all chromosomes. A serious criticism of them in the capacity of structural bases of genetical genes is supplied by their insufficient number. Further, the crossing points of the chromosomal spirals are much more numerous in the earlier stages of the meiotic divisions and become still fewer and fewer as the development of the gametic cells progresses.

Reference

1. Jeffrey, Edward C. *Science*, 1945, **102**, 653–656.

Poland in the World of Science

Ignace Zlotowski

Polish Representative to the United Nations Atomic Energy Commission

SCIENTIFIC KNOWLEDGE REPRESENTS A product of multilateral international cooperation. By pooling their individual contributions, scientists of various countries have made possible the developments in science and technology which constitute the foundations of our present civilization. In the course of their work, they are inspired by the thought that they are collaborating with other researchers of the world to solve scientific problems. In fact, international cooperation has always been a powerful stimulant in advancing human knowledge.

That the scientific world is truly a 'one world' has been triumphantly demonstrated by the release of atomic energy. This brilliant achievement in nuclear physics could never have been attained without the scientific and technological knowledge laboriously accumulated for the five decades since the discovery of radioactivity by the French scientist, Becquerel, and the separation of polonium and radium by Marie Sklodowska-Curie. Today it is in the best interests not only of science but also of human welfare to continue assuring close cooperation between the scientists of the world. Science is no longer a complementary element in each country's economic and political life but an indispensable part of it. In this atomic age, scientific progress constitutes the foundation of every nation's future; it is, in fact, the cornerstone of modern democracy.

Unfortunately, many countries devastated by the war are unable today to take an active part in advancing science and technology. Despite their long scientific tradition, they are practically left out in the scientific race toward a better and happier tomorrow. Perhaps the most tragic example of devastation that was brought about by the Nazi barbarians in the field of science was the destruction of scientific and cultural life in Poland. The Nazis pursued a ruthless policy of systematic extermination of intellectuals. Seventy members of the Polish Academy of Sciences perished, while 40–70 per cent of the total membership of university staffs were lost. One recalls here the case of Prof. Kalandyk, of Poznan, who served as a target for bottles thrown at him at a party for SS men. Hand in hand with the destruction of intellectuals went the eradication of Polish cultural life. Six thousand and four hundred schools, 3,350 cultural institutions, 16,000,000 books, and 700,000 collections and maps were destroyed by the Nazis.

In spite of this overwhelming destruction, Poland is making tremendous progress in restoring higher education. Most of the universities that existed in prewar Poland have been reopened, and seven new ones have

come into existence since the end of the war. Several universities and cultural institutions previously located in the eastern territories, which formerly belonged to Poland, have been transferred to Poland proper. The Jan Kazimierz University of Lwow, for example, has become the University of Wroclaw, and the Stefan Batory University of Wilno is now the Mikolaj Kopernik University of Torun. Among the present universities, there are a number of private institutions such as the Catholic University of Lublin and the School of Political Sciences at Warsaw. In fact, the total student enrollment at private universities in the school year of 1945–46 was 7,142, as compared with 6,022 in 1933–34. In addition to the universities, there has been a revival of the so-called "nonacademic schools," which grant certificates or professional diplomas upon graduation but do not issue degrees. In this category belong normal schools and higher agricultural schools.

What are the problems that now confront the universities of Poland? Perhaps the following figures will help to answer the question. Nine hundred and eighty-two university chairs are occupied, while 630 are still vacant. Twenty-five per cent of all laboratories are still closed because of lack of personnel and equipment. There are present in Poland only 739 permanent professors and as many as 1,453 so-called "temporary professors" who either rotate among a few universities or teach simultaneously at a number of schools. It is interesting to note the great discrepancy in numbers between undergraduate and graduate students. In 1946–47 52,000 undergraduate and only 200 graduate students were enrolled. This lack of proportion is, of course, a result of the war. During that time the schooling of a great many young people was interrupted, and only now are they able to start where they were forced to leave off. Thus, in the school year 1945–46, 1,850 undergraduate and only 211 graduate students received diplomas. Another striking fact is that out of those 1,850 undergraduate students, only 445 were women; out of 211 graduate students, only 16. This is, of course, also due to the conditions produced by the war.

It must be remembered, however, that the blow dealt by the Nazis to Polish science is not the first one that Poland has suffered. The rich Polish scientific tradition was interrupted more than once during the last 150 years. It has been the strange fate of the country that so many of her outstanding scientists lived abroad. Prior to World War I, national persecutions forced numerous Polish scientists, among them Marie Sklodowska-Curie, to leave their native land. Between the two wars, the Fascist regime ruling Poland caused many scientists to emigrate abroad, and, with the outbreak of World War II, more scientists sought refuge in foreign countries. The largest damage to Polish science was brought about by the planned extermination of scientists pursued by the Nazis.

If the world wants to benefit from the contributions of Polish scientists as it has done heretofore and at the same time revive Polish science, certain definite steps can be taken. First of all, contacts between Polish scientists and those in other countries must be renewed and maintained. This would involve supplying Polish scientists with books, periodicals, and other scientific publications as well as much-needed equipment. Secondly, the new crop of young scientists emerging from all classes of Polish society should be assisted. For the first time in Poland's history, the universities are open to all classes, in contrast to the prewar policy when higher education was available only to privileged groups. In this respect a number of scholarships might be established to enable promising Polish students to study abroad. Of course, aid coming from abroad would not solve all the problems which are confronting Poland. There is a large area of endeavor where the burden falls entirely on the Polish scientists themselves. Fully aware of this obligation, those who survived Nazi brutality are utilizing their knowledge and ability to build Polish science on a real democratic foundation.

The problem of helping devastated countries to revive their national scientific life ought to be solved by all scientists of the democratic world, in order that the international community of scientists may become a living reality. Poland is only one example of a country with new possibilities for scientific work and scientific culture in need of help to develop its potentialities. Such help not only will prove to be of great importance to Poland but will also bear scientific fruits of benefit to humanity.

Everyone, and particularly the scientist, realizes to what extent modern science can be used for destructive purposes. The bright opportunity to use science constructively by rebuilding destroyed countries now presents itself. By so doing "the brotherly spirit of science which unites into one family all its rotaries of whatever grade and however widely dispersed throughout the different quarters of the globe"—as Thomas Jefferson pointed out—will manifest itself by utilizing science to create conditions favorable for a free, full, and happy life for peoples all over the world.

Association Affairs

Association Membership Dues Increased

Nearly every scientific society and educational institution is now under financial pressures as a consequence of greatly increased costs of operation. Most of them a year or more ago increased their dues, tuitions, etc., and many of them are making further increases this year. But by strict economy the American Association for the Advancement of Science has heretofore not had to make any increases in the dues of its members. Now it must do so.

Although all operating expenses of the Association have risen greatly in recent years, the present increase in annual dues of members from $5.00 to $6.50 is barely sufficient, for the sake of illustration, to meet the increased costs of printing *Science* and *The Scientific Monthly*. Of course, the increase in dues could be measured against other expenses of the Association, but not so simply. Since every member of the Association receives with his membership either *Science* or *The Scientific Monthly*, the increase in dues will provide for the increased costs of the journals but not for increases in other expenses. These are being met by economies which are possible with a greatly increased membership, and from increases in receipts from advertising in *Science* because of its correspondingly larger circulation.

In 1940 there were about 21,000 members of the Association; now there are 33,000, 6,000 new names having been added to the membership roll in the past 12 months. Less than four years ago the circulation of *Science* was 17,000; now it is 25,000, the increase putting it in a higher class as an advertising medium. When its circulation exceeds 30,000 (within 18 months?), it will rate still higher as an advertising medium. These considerations make clear the fact that when members of the Association nominate their friends for membership they are indirectly giving much needed financial assistance.

The Association's weekly journal, *Science*, is in many respects similar to its prototype, *Nature*, a weekly magazine edited and published by Macmillan & Company, Ltd., the great scientific book publishers in London, England. *Nature*, now in its 160th volume, has a wide circulation throughout the world. In format and contents *Science* is generally similar to *Nature*. Their pages are of the same size, their issues normally consist of 48 pages of text and advertising, and their contents are roughly similar. *Nature*, too, has had to contend with high costs of printing—perhaps higher than in this country. To meet these costs the annual subscription price for *Nature* has been increased to 4 pounds, 10 shillings, which is equivalent to a little more than $18 in American money at present rates of exchange. In comparison with this subscription rate the membership dues of $6.50 in the Association, including subscriptions for *Science* or *The Scientific Monthly*, are moderate indeed.

From the business point of view the publication of the Association's journals is a substantial undertaking. Each week more than 25,000 copies of *Science* are mailed out, or nearly 2.5 tons of paper. Each month 16,000 copies of *The Scientific Monthly* are mailed to members and nonmember subscribers, or about 3.25 tons of paper. The total for both journals per year is approximately 167 tons of paper. The cost of paper, printing, and mailing next year will be around $140,000, or more than $500 each working day.

In explaining in some detail the magnitude and cost of printing *Science* and *The Scientific Monthly*, partly because they are simplest and easiest understood, undue emphasis has been placed upon this part of the Association's activities. In the first place, the journals must be edited and advertisements must be secured and made ready for printing. The Association also publishes technical symposium volumes, which are edited, advertised, sold, and mailed by the office staff. The accounting force must keep accurate, classified records of all receipts and disbursements, however small the items. The billings to members and advertisers exceed 40,000 pieces of mail.

It might be inferred from the fact that it has become necessary to increase membership dues by $1.50 per year that the future of the Association is uncertain. Such a conclusion would be quite contrary to the opinion of its officers. Since 1938, the last year before the war broke out in Europe, the membership of the Association has increased from 19,000 to 33,000, and the rate of increase now is much greater than it has ever been in the past.

In this same period the following results were accomplished: (a) The symposium volumes comprising a total of about 4,000 quarto pages, were established, edited, advertised, and sold from the Association's offices, and more than $83,000 was received from their sale. (b) The AAAS-Gibson Island Research Conferences (now Chemical Research Conferences) were established by Dr. Neil E. Gordon and financed by contributions of $1,000 each from 33 industrial laboratories. In the interval since their founding, 79 five-day research conferences have been held, with a total attendance of about 4,000 scientists. (c) In 1945 members of the Association, in response to a circular letter from the administrative offices, contributed about $95,000 toward carrying out a somewhat nebulous plan for a permanent home. Most of this sum was applied, in 1946, toward the purchase of the square facing Scott Circle. (d) The cumulative balance from operations of the administrative offices in the 9 years since 1938 has amounted to $196,000, of which about $96,000 has been applied toward the payment for *Science* and *The Scientific Monthly* under the contract with Dr. J. McKeen Cattell for their purchase, and about $80,000 to complete the purchase of the entire square on which the offices of the Association are now located. (e) Since the close of the war the Association has purchased a considerable amount of much-needed office equipment and is now well supplied for efficient operations.

Although the costs of operations are at present distressingly high, the over-all picture for the Association is most encouraging. Where else in the whole world is there an organization having as great an opportunity to advance science as has the AAAS?

F. R. MOULTON
Administrative Secretary

NEWS *and Notes*

Earlham College, Richmond, Indiana, celebrated its 100th anniversary September 19–23 with a varied program of events in which scientists played an outstanding part. On the evening of September 19 Wendell M. Stanley, of the Rockefeller Institute for Medical Research, Nobel Prize winner and Earlham alumnus, presented an illustrated address on "Studies on Purified Influenza Virus," and the forenoon session September 20 consisted of three addresses: "What Is the Scientific Method?" by Charles F. Kettering, General Motors Corporation; "Science as a Force for Peace" by Dr. Stanley; and "Psychological and Medical Research in Aviation" by Walter R. Miles, professor of psychology, Yale University School of Medicine, who is also an Earlham alumnus. The latter part of the celebration centered around the founding of the College and a conference on "The Place of Religion in the Reconstruction of Civilization." Addresses on "Earlham in England" and "Earlham in America" were given, respectively, by Frank Woods, the Vicar of Huddersfield, England, and a member of the Gurney family of Earlham Hall, for which Earlham College was named, and by President Jones. Other invited speakers included Robert M. Hutchins, chancellor of the University of Chicago, Rufus M. Jones, emeritus professor of philosophy, Haverfo d College; and Walter D. Fuller, president, Curtis Publishing Company.

From the celebration emerged some interesting facts about this Quaker College's first 100 years: Of all the coeducational colleges in the country, in 1940 Earlham ranked first in percentage of living graduates listed in *Who's who in America*; in addition, Earlham men listed in the 1944 edition of *American men of science* were five times the national average of all colleges and universities on a total enrollment basis; over a 9-year period covered by a recent survey made by the Association of American Medical Colleges no graduate of the College had failed in first-year medicine; and finally, of the some 10 Nobel Prizes awarded to Americans in the field of science, two were received by former students at Earlham—Wendell M. Stanley and Harold C. Urey.

About People

C. W. Brabender, electrical engineer and physicist, and a well-known designer of testing equipment used by food processors, and **A. W. Fornet,** formerly consultant to the Royal Baking Powder Company, Berlin, and European expert on grain, flour, and breadmaking, are the first foreign scientists to be assigned to the Quartermaster Food and Container Institute for the Armed Forces, Chicago.

James H. Bywaters, U. S. Department of Agriculture Poultry Research Laboratory, East Lansing, Michigan, has been appointed research poultryman, Virginia Agricultural Experiment Station, Blacksburg, Virginia. Dr. Bywaters will plan and conduct poultry research projects aimed toward development and guidance of the poultry industry in Virginia.

Alan Gregg, director, The Medical Sciences, Rockefeller Foundation, New York City, and **Karl M. Bowman,** Langley Porter Clinic, San Francisco, have been appointed members of the National Advisory Mental Health Council, U. S. Public Health Service, succeeding **Frank F. Tallman,** commissioner of mental hygiene, Department of Public Welfare, Columbus, Ohio, and **George S. Stevenson,** medical director, National Committee for Mental Hygiene, New York City, who were both appointed consultants in mental health to the U. S. Public Health Service upon the expiration of their terms on the Council.

Tibor Rado, chairman, Department of Mathematics, Ohio State University, is on leave of absence during the autumn term to serve as visiting professor at the University of Puerto Rico.

Stuart Mudd, School of Medicine, University of Pennsylvania, was elected as the American Delegate of the Executive Committee of the International Union of Biological Sciences at its 11th General Assembly held on July 28 at the Royal Danish Academy of Science, Copenhagen.

Arthur R. Colmer, until recently of West Virginia University, is now associate professor of bacteriology, Louisiana State University, Baton Rouge.

Robert A. Conover, Department of Botany, University of Illinois, has been appointed associate pathologist, University of Florida Subtropical Experiment Station, Homestead, Florida.

Stanley W. Oexemann, Carleton College, has been named professor of biology, Carthage College, Carthage, Illinois.

William H. Summerson, formerly associate professor of biochemistry, Cornell University Medical College, is now chief, Biochemistry Section, Medical Division, Army Chemical Center, Maryland.

Emmet F. Hitch, special assistant to the management, E. I. du Pont de Nemours & Company's Chambers Works, Deepwater Point, New Jersey, has resigned after 29 years of service to become professor, Department of Chemistry, Purdue University.

Robert Kriss Wyant, formerly of the U. S. Geological Survey, Albuquerque, New Mexico, has been appointed assistant curator of Economic Geology, Chicago Natural History Museum.

William H. Hollis, research associate and instructor of industrial accident prevention, Center for Safety Education, New York University and Stevens Institute of Technology, has been appointed senior safety engineer, Los Alamos Scientific Laboratory, where he will continue basic research in accident causation and in industrial safety education program development.

Karl Lehmann, professor of fine arts and director, Archaeological Research Fund, New York University, who has been directing the salvaging of monuments in Greece this summer (*Science*, June 20), recently returned to this country after arranging for the continuation of the University's archaeological research and excavation work, interrupted by World War II, on the island of Samothrace.

Adrien Albert, who has been conducting work on the physics and chemistry of drug action at the University of Sydney since 1938, has been appointed to the staff of the Wellcome Research Institution, London, to initiate similar studies there.

Arthur G. Vestal, who has been on sabbatical leave from the Department of Botany, University of Illinois, during the past year to conduct ecological studies of the grasslands of California, has returned to the campus.

Myron Gordon, geneticist, New York Aquarium, New York Zoological Society, and **Caryl P. Haskins,** director, Haskins Laboratories, have been appointed research associates, Department of Animal Behavior, American Museum of Natural History. Together with **T. C. Schneirla** and **L. R. Aronson,** curatorial members of the Department, they form the nucleus of a group which is directing its attention toward studying factors underlying species behavior patterns in relation to problems of genetics and evolution.

Dexter H. Reynolds, group leader in charge of the Physical Laboratories, Central Research Division, Monsanto Chemical Company, Dayton, Ohio, has been appointed research professor and technical director, Division of Research and Development, University of New Mexico. Dr. Reynolds assumed his new duties September 1.

Grants and Awards

The Worcester Foundation for Experimental Biology has, during the fiscal year ending May 31, 1947, been the beneficiary of research grants totaling approximately $100,000, according to a report submitted by Hudson Hoagland and Gregory Pincus, co-directors. Donors of the grants included the Applied Research Foundation, San Antonio, Texas; the Donner Foundation; the American Cancer Society, Massachusetts Division; the G. D. Searle Company; the Committee on Endocrinology, National Research Council; the Council on Pharmacy and Chemistry, American Medical Association; the American Academy of Arts and Sciences; the Schering Corporation; and the U. S. Navy. Since July 1 the Foundation has received grants of $9,236 from the Cancer Committee of the U. S. Public Health Service and $30,469 from the Committee on Problems of Aging of the U. S. Public Health Service.

The Foundation is a nonprofit educational and research institution engaged in basic biological investigations. Part of its income is derived from annual contributions of Worcester citizens and institutions who subscribe to memberships. The Foundation's 450 members contribute approximately $25,000 per year toward overhead. To quote Drs. Hoagland and Pincus, "this community aid for basic science, given in the same spirit that characterizes its support of music, art, and other civic institutions, is most unusual and worthy of note."

The New York Academy of Sciences has received grants totaling $10,000 from the Anna Fuller Fund, Jane Coffin Childs Memorial Fund for Medical Research, NRC Committee on Growth acting for the American Cancer Society, and National Advisory Cancer Council of the National Cancer Institute, for purposes of aiding the Academy in publishing the book, *The biology of melanomas*. This will contain 27 papers, most of which were read at the Academy's conference on "The Biology of Normal and Atypical Pigment Cell Growth," held at the American Museum of Natural History, November 15–16, 1946. Myron Gordon, geneticist, New York Aquarium, New York Zoological Society, and organizer of the pigment cell conference, is consultant editor of the volume. Publication is expected this year. The New York Academy's editor is Roy W. Miner, and its executive secretary is Mrs. Eunice Thomas Miner.

Industrial Laboratories

The Eastman Kodak Company has announced a new method of making silver nitrate crystals for use in photographic manufacturing. The former method of production of the crystals by evaporation in open porcelain dishes is now replaced by a system using machinery that makes the crystals continuously and dries them in a few minutes. The drying process alone used to take several days. Chunks of silver, the material which makes modern photography possible, are dissolved in nitric acid and the resulting greenish liquid goes into storage tanks from which it is slowly pumped into 1,000-gallon stainless-steel crystallizers. Here the liquid undergoes constant stirring and addition of fresh silver nitrate solution, which makes for formation and growth of crystals in the lower part of the tank. After being drawn from the tank through a pipe, poured into perforated steel baskets, and relieved of most of their moisture by a spinning of the baskets, the crystals are redissolved in distilled water and the crystallizing process repeated. A rotary drying drum is finally used for completely drying the crystals.

Irving I. Rusoff, formerly head of nutrition, Fleischmann Laboratories, Standard Brands, Inc., has been appointed section head, Organic Research Laboratory, Central Laboratories, General Foods Corporation.

Meetings

The William James Lectures on Psychology will be given this year at Harvard University by B. F. Skinner, Indiana University, on the topic "Verbal Behavior." Dr. Skinner will speak at 4:15 P.M. on Fridays as follows: October 10, "The Age of Words"; October 17, "Verbal Behavior as a Scientific Subject Matter"; October 24, "Types of Verbal Behavior"; October 31, "Words and Things: The Problem of Reference"; November 7, "Multiple Sources of Verbal Strength"; November 14, "Making Sentences"; November 21, "The Effect Upon the Listener"; November 28, "Understanding: Real and Spurious"; December 5, "Thinking in Words"; and December 12, "The Place of Verbal Behavior in Human Affairs."

The Electronic Components Subcommittee, Aircraft Radio and Electronics Committee, Aeronautical Board, is sponsoring a technical symposium on "Printed Circuits" to be held at the Interior Department Auditorium, 18th and C Streets, N. W., Washington, D. C., October 15, beginning at 9:30 A. M. Eleven technical papers will be presented under the direction of Cledo Brunetti, National Bureau of Standards. Speakers will be included from the Army Air Forces; Navy Bureau of Aeronautics; National Bureau of Standards; Centralab Division, Globe-Union, Inc.; E. I. du Pont de Nemours & Company, Inc.; International Resistance Company; Continental Carbon Company; Signal Corps Engineering Laboratories; Remington Arms Company; Corning Glass Works; Metaplast Company; Altair Machinery Corporation; and Spraywire Laboratories, Inc. The Aeronautical Board is issuing invitations, a limited number of which are still avail-

ble upon request to Printed Circuits Symposium Committee, Navy Department, Room 1W91, Washington 25, D. C.

A technical symposium on the National Bureau of Standards Casting Resin, developed by the Bureau for potting high-frequency radio equipment, will be held in the conference room of the Bureau's Materials Testing Laboratory, Washington, D. C., October 16, beginning at 9:30 A.M. The symposium is open to interested representatives of industry and government. The casting resin, primarily designed for potting high-impedance, high-frequency electronic equipment, affords ruggedness, moisture-proofing, and circuit stability. The speakers will include Harry Diamond, chief, Ordnance Development Division, in which the resin was developed, and P. J. Franklin and M. Weinberg, who were active in its formulation. An open discussion of the subject will follow the addresses.

All registrants for the Pacific Industrial Conferences, running concurrently with the 1947 Pacific Chemical Exposition, October 21–25, San Francisco, are invited to attend the programs presented by the participating groups, including the California Section, American Institute of Chemical Engineers; American Society for Testing Materials; American Institute of Mining and Metallurgical Engineers; Golden Gate Paint and Varnish Production Club; Northern California Rubber Group; Pacific Insecticide Institute; Institute of Food Technologists; Western Chemical Market Research Group; Analytical Group, California Section, American Chemical Society; Petroleum Group, California Section, American Chemical Society. R. D. Stewart, University of California, is program coordinator for the Conferences.

The American Anthropological Association will hold its annual meeting in Albuquerque, New Mexico, December 28–31, inclusive, with the University of New Mexico as host institution. An invitation has been extended to the Society for American Archaeology to meet jointly with the Association at that time.

The question of soil surveys in the Caribbean was considered at some length during the second session of the West Indies Conference, which met in St. Thomas, Virgin Islands, in February-March 1946. At that time it was recommended to the Caribbean Commission that, because of the limited number of qualified soil scientists in that area, an informal meeting of soil scientists nominated by the governments of the Caribbean territories and those of the U. S. Department of Agriculture be called at an early date. Following upon this recommendation the Commission appointed a subcommittee consisting of H. J. Page (chairman), principal, Imperial College of Tropical Agriculture, Trinidad; D. Blanche, acting head, Agricultural Service, Martinique; J. A. Bonnet, head, Soils Department, Agricultural Experiment Station, University of Puerto Rico; F. Hardy, professor of chemistry and soil science, Imperial College of Tropical Agriculture; and H. J. Muller, agricultural chemist, Department of Agricultural Economics, Surinam. This subcommittee, which met in Trinidad March 15–18, 1947, recommended in turn that a Conference of Soil Scientists be held in Puerto Rico in 1948, under the auspices of the Committee on Agriculture, Nutrition, Fisheries, and Forestry of the Caribbean Research Council. The proposed agenda includes: (1) presentation and discussion of collected data on soil-forming factors of the various territories; (2) standardization of field and laboratory methods of soil surveys; (3) discussion of different systems of soil classification and mapping; (4) formulation of a detailed regional program of surveys; (5) survey of problems of soil erosion, conservation, and renovation; and (6) practical application of soil surveys to land utilization. It is intended that the proposed conference be as representative as possible. The working committee which is preparing for the Conference has not yet settled upon a definite date.

"Earth Sciences From the Oceanographic Point of View" was the general topic of discussion at the second session of the New England branch of the American Geophysical Union, held at the Marine Biological Laboratory, Woods Hole, September 18, under the chairmanship of C. O'D. Iselin. Highlight of the meeting was Maurice Ewing's talk on the recently concluded expedition of the *Atlantis* to the mid-Atlantic Ridge (*Science*, July 18), during which considerable quantities of rock from the steep slopes of the Ridge were obtained for examination and classification. A paper by Reverend Daniel Linehan, of Weston College, Massachusetts, described the tripartite system of recording the direction and location of a hurricane through three U. S. Government seismic stations set up in the West Indies. W. D. Urry, Carnegie Institution of Washington, described a method whereby the age of sediments on the ocean bottom may be determined by analysis of their radium content. Prediction of average monthly conditions under which Navy landing craft and seaplanes can safely be operated near beaches is made possible by an instrument described by H. R. Seiwell. J. B. Hersey and Hilary B. Moore, Woods Hole Oceanographic Institution, discussed the question of whether shrimps or fish cause an unusual recording on ships' sonic sounding instruments. E. E. Watson, also of the Institution, described the bathyclinograph, by which a vertical current profile may be obtained. Henry Stommel and J. L. Worzel, both of the Institution, discussed, respectively, a theoretical study of large-scale ocean currents which demonstrates that discrepancies between the facts that great ocean currents are primarily driven by the force of permanent wind systems and that these currents are not most intense where wind is present are a logical outcome of influence of the earth's rotation, and gravity observations made at sea.

The Symposium on the Use of Isotopes in Biology and Medicine held at the University of Wisconsin September 10–13 brought together over 500 leaders in many branches of science, including some 20 foreign scientists—the largest scientific gathering ever devoted to the exchange of information about isotopes. The papers presented at the symposium, which were oriented toward the use of isotopes as a laboratory tool in a variety of fields including medicine, biochemistry, chemistry, physics, bacteriology, genetics, botany, and cancer research, will be published in monograph form within a few months.

Recent Deaths

William C. Anderson, 83, dean emeritus, Brooklyn College of Pharmacy, Long Island University, died in Keyport, New Jersey, September 3.

Neil A. Miner, 49, professor of geology at Cornell College, Mount Vernon, Iowa, died September 16 following an illness of several months. Dr. Miner was known for

his work on Pleistocene geology and sedimentation. He was founder and director of Camp Norton, Wind River, Wyoming, for summer instruction in field geology.

William Seaman Bainbridge, 70, professor of operative gynecology, New York Post-Graduate Hospital and School, professor of surgery, New York Polyclinic Medical School and Hospital, and surgeon and secretary, Research Committee, New York Skin and Cancer Hospital, died September 22 at Danbury Hospital, Connecticut.

Pierre Lecomte du Noüy, 64, at one time chief, Division of Molecular Biophysics, Pasteur Institute, died September 22 in Roosevelt Hospital, New York. Dr. du Noüy, a former associate member, Rockefeller Institute, was the author of *Human destiny*, published in February.

Benjamin Carpenter, Jr., 51, associate professor of physics, Navy Pier branch, University of Illinois, died September 24 of a heart attack shortly after attending a noon class.

Synthetic star sapphires and rubies, made by the Linde Air Products Company, a unit of Union Carbide and Carbon Corporation, were shown for the first time at the American Museum of Natural History, New York City, on September 24. F. H. Pough, curator of Physical Geology and Mineralogy at the Museum, indicated that these can be distinguished from the natural star stones by the curving lines which appear on the backs of synthetic stones, which may be detected by jewelers with no great difficulty. It is not anticipated that the new synthetic stones will have any deleterious effect upon the fine star stone market, even though synthetic rubies require the eye of an expert for distinction. Because each is individually processed and it is difficult to achieve uniformity in production, the synthetic stones will vary in quality, and it will be as hard to match them as to match natural stones.

The Istituto Italiano di Idrobiologia, Pallanza, Italy, founded in 1933 with private endowment and located on the north shore of the Lago Maggiore, has announced that it has space available for foreign guests. There is also a branch at Varenna, on the east shore of Lago di Como. The main activities at the Institute are in the fields of fresh-water ecology, systematics, planktology, genetics (especially *Drosophila*), and evolution. It publishes a series of *Memorie*, the third and fourth volumes of which are to appear shortly, and it is desired to arrange exchanges between these and journals or proceedings of American societies and laboratories. The Institute's equipment for field and laboratory work provides ample facilities for limnological investigations on both the great and the smaller lakes of the Alpine region. The equipment of the genetic laboratories is particularly suitable for studies on population genetics and on biophysical problems. The Institute offers free lodging and laboratory space to foreign guests, up to a maximum of five at a time. For further information, applications, and arrangements, those interested should contact Dr. E. Baldi, director, Istituto Italiano di Idrobiologia, Pallanza (provincia Novara), Italy.

The Society for the Study of Evolution has recently published the first issue (Vol. I, Nos. 1–2, March–June 1947) of *Evolution*, a quarterly "international journal of organic evolution" which is under the editorship of Ernst Mayr, The American Museum of Natural History, New York City 24. Assisting Dr. Mayr is a group of associate editors including C. Epling, Los Angeles; J. B. S. Haldane, London; J. Huxley, London; G. L. Jepsen, Princeton; A. Müntzing, Lund; T. S. Westoll, Aberdeen; R. W. Chaney, Berkeley; C. D. Darlington, London; R. A. Fisher, Cambridge, England; C. Hubbs, La Jolla; N. Newell, New York; J. Piveteau, Paris; Th. Dobzhansky, New York; N. P. Dubinin, Moscow; B. Rensch, Münster; A. S. Romer, Cambridge, Massachusetts; G. L. Stebbins, Berkeley; and W. B. Turrill, Kew, England. Subscriptions to the journal ($6.00 per volume) may be ordered through the business manager, K. P. Schmidt, Chicago Natural History Museum, Chicago 5, Illinois. This journal, designed to meet the acute need for a publication devoted exclusively to results of research in the field of evolution, will bring together contributions from all fields of biology.

The Library of the Botanical Garden and Institute and the Cryptogamical Laboratory, center of studies on fungicides, human and comparative mycopathology, and mushroom culture, Pavia, Italy, wishes to exchange biological and general scientific periodicals and reprints with U. S. organizations and institutions. Almost complete series of *Atti* (Transactions; 43 vols. from 1888 on) and *Archivio Botanico* (22 vols. from 1925 on) are available as well as reprints of the same periodicals and of *Mycopathologia* and *Il Farmaco*. Communications may be addressed to the director, R. Ciferri, P. O. Box 165, Pavia, Italy.

The excellent technical library, Teknillinen Korkeeoulu, Institute of Technology, Helsinki, Finland, was bombed and totally destroyed during the recent war, according to a report from Arthur E. Morgan, Community Service, Inc., Yellow Springs, Ohio, who was a recent visitor there for the American Friends Service Committee. Martti Levon, director of the Institute, will welcome gifts of scientific and technical books and periodicals from this country to take the place of those destroyed. Any such gifts should be marked for the Institute of Technology, Helsinki, and sent to the Legation of Finland, 2144 Wyoming Avenue, N. E., Washington, D. C. J. T. Jutila, Finnish Minister, will arrange for their shipment.

Make Plans for—

The New York Academy of Medicine, 20th Graduate Fortnight, October 6–17, 2 East 103rd Street, New York City.

Electrochemical Society, Fall Convention, October 15–18, Boston.

American Chemical Society, Philadelphia Section, Fall Meeting, October 16, Franklin Institute, Philadelphia.

National Conference on Industrial Hydraulics, Third Annual Meeting, October 16–17, Hotel Continental, Chicago.

Society of Rheology, October 30–31, New York City.

American Institute of Electrical Engineers, Midwest General Meeting, November 3–7, Chicago.

American Institute of Chemical Engineers, November 9–11, Detroit, Michigan.

American Association for the Advancement of Science, 114th Meeting, December 26–31, Chicago, Illinois.

COMMENTS

by Readers

Taxonomists and zoologists whose work requires close attention to the scientific names of animals are frequently confronted with names that were badly formed when first proposed or that appear to be spelled erroneously in one way or another. Even more common are inadvertent errors and intentional emendations when names are cited subsequently to the original proposal. If only a few animals were named, these orthographic deviations would be of small consequence. The names could be emended to correspond with the best classical orthography (for the names must be Latin or latinized), and all would be well. But since there are many hundreds of thousands of named animals, the situation is not so simple. Obviously, each genus or species of animal can have only one valid name spelled in only one way, and no two may have the same name. Hence, since many names are inevitably very similar, great confusion can result if each author is free to spell any name in the way that pleases him most. Purely inadvertent errors in subsequent citations can likewise cause confusion.

Under Article 19 of the International Rules of Zoological Nomenclature the original orthography of a name is to be preserved, except that emendations may be made under certain restricted circumstances. Unfortunately, Article 19 is somewhat ambiguous as to what these circumstances are, and it likewise fails to cover fully the status of emendations and subsequent erroneous spellings. This ambiguous and incomplete coverage has led to widely varying practices among taxonomists and to considerable confusion.

In view of these considerations the undersigned subcommittee of the Smithsonian Institution Committee on Zoological Nomenclature, composed of taxonomists of the U. S. National Museum, the Bureau of Entomology and Plant Quarantine, the Geological Survey, and the Fish and Wildlife Service, gave many hours to considering the problem and has proposed the following suggestions for the rewording of Articles 19 and 20 of the present Code.

The full Committee approved the new interpretations and directed the subcommittee to publish them for consideration and discussion by zoologists. If substantial agreement can be reached, it may be in order to transmit the suggested articles to the International Commission for submission to the International Congress of Zoology, the only body with power to amend the Code, which will meet for the first time since 1935 at Paris during July 1948.

Discussion and constructive criticism by letter or publication would be welcomed by the Committee. The wording of these proposals, which are intended to bring together in a coherent and logical whole the present Articles and the pertinent Opinions of the International Commission, as well as one new corollary principle, has been very carefully studied in an attempt to cover in principle all contingencies. It is to be taken literally and strictly. The words "error" and "emendation" are defined in paragraph II.

Article 19. I. The original orthography of a name is to be preserved unless it can be demonstrated from the original publication itself that there has occurred a *lapsus calami*, a printer's error, or an error of transcription. Incorrect transliteration and misuse of connective letters are not errors in this sense. [See Opinions 8, 26, 36, 60, and 70. (Opinions 41, 61, and 63 appear to us to be inconsistent with the rest of the Rules and Opinions. We are unable to correlate them with the principles outlined above.)]

(a) When demonstrable from the original publication, such errors in original spelling are correctable and are to be treated as if corrected wherever they occur; the corrected spellings are justified emendations and take the place of the original (erroneous) spellings in all respects, including date and authorship. The erroneous spellings have no separate status in nomenclature, do not preoccupy, are not available as replacement names, and never acquire validity by citation in synonymy. [See Opinion 26.]

(b) If an original spelling is suspected of being erroneous but cannot be so demonstrated from the original publication itself, it is not subject to change and is to be treated in all respects as a properly formed name. [See Opinion 34.]

II. In subsequent publications variant spellings may occur either through intention or misadventure. For the purpose of this section emendations are defined as changes that are originally stated to be intentional, or are demonstrably so; errors are any changes that are not emendations, including those of doubtful status which cannot be demonstrated from the original publications to be emendations.

(a) Emendations that are justified under Section I above (see Ia).

(b) Emendations that are not justified under Section I above are separately validated and are objective junior synonyms of the name in its original form; they are available as replacement names; they preoccupy any later names of the same spellings; and their author is the one who proposed them as emendations. [See Opinions 34, 120, 125, and 148 (with supplementary note).]

(c) Errors, as defined above, are correctable and are to be treated as if corrected wherever they occur. They have no separate status in nomenclature, do not preoccupy, are not available as replacement names, and never acquire validity by citation in synonymy. [See Opinion 29.]

Example: The generic name *Oxytelus* has been written erroneously as *Otytelus*, *Oxitelus*, *Oxyletus*, *Oxyteius*, *Oxyteles*, *Oxytelius*, *Oxytellus*, *Oxytetus*, and *Oyxtelus*. These are all to be corrected and have no separate status.

Example: In 1833 Germar (*Rev. Entomol.*, **1**, 175) published the name *Dictyophara* (Homoptera). Among the numerous variant spellings of this name that have occurred is the *lapsus calami Dictyonota* of de Seabra 1930 (*Arq. Secc. Biol. Par.*, **1**, 347). This *lapsus* may have been caused by association with *Dictyonota* Curtis (Hemiptera), with which insect it could not have been confused. The error is to be corrected and has no separate status in nomenclature.

Article 20. In forming names based on sources using an expanded Latin alphabet, the exact spelling of the source *as quoted* is to be preserved, including diacritic marks. (The modern expanded

Latin alphabet contains many characters unknown to the Romans. Among these are: ö, ñ, ø, č, é, ç, å, ž, and many others. These are to be used whenever appropriate. Failure to use them in the name when they are quoted in the source will produce an erroneous spelling which is to be corrected to the proper form.) Names introduced in conflict with this principle are to be corrected in accordance with Article 19, Ia. [See Opinion 27; also Opinion 8, paragraph 4, of the Discussion.]

Example: In forming a name to honor the Swedish hemipterist, Carl Stål, the å should be used instead of a, as *Stålia*, but *Stalia*, if introduced without statement of source, would be acceptable. It could be corrected to *Stålia* only if proof of an error was in the original publication. (RICHARD E. BLACKWELDER, J. BROOKES KNIGHT, and CURTIS W. SABROSKY, *Washington, D. C.*)

The effects of a new class of antifilarial compounds, cyanines, on the metabolism of adult filariae and growth of bacteria have recently been described by Welch, *et al.* and by Brooker and Sweet (*Science*, May 9, pp. 486, 496). A striking similarity is obvious in the action of the cyanines and the antimalarial drug, atabrine.

Welch, *et al.* report that cyanine #348, (1-amyl-2,5-dimethyl-3-pyrrole)(1-6-dimethyl-2-quinoline) dimethinecyanine chloride, inhibited the respiratory activity of the filariae at low concentrations of the drug. This was associated with a compensatory increase in glycolysis. An analogous situation was reported in the action of atabrine in the glucose metabolism of *Plasmedium gallinaceum* (M. Silverman, *et al. J. inf. Dis.*, 1944, **75**, 212). Low concentrations of atabrine inhibited the respiratory activity of *P. gallinaceum*, with a resultant increase in glycolysis.

Brooker and Sweet reported that the growth inhibition of *Escherichia coli* by cyanine #348 was partially reversed by high concentrations of thiamine, riboflavin, nicotinic acid, and pantothenic acid but not by pyridoxine and p-aminobenzoic acid. Identical effects were obtained with these B vitamins in the growth inhibition of *E. coli* by atabrine by Silverman and Evans (*J. biol. Chem.*, 1944, **154**, 521). It was also shown that the naturally-occurring polyamines, spermine and spermidine, are active antagonists of the inhibitory effects of atabrine in the growth of *E. coli*. Both reports (Brooker and Sweet, Silverman and Evans) indicated that natural materials contain antagonists for cyanine #348 and atabrine whose activity cannot be replaced by the well-characterized B vitamins.

It seems quite possible that when the modes of action of cyanine #348 and atabrine are established, the fundamental mechanisms involved will be essentially the same. (MILTON SILVERMAN, *Division of Physiology, National Institute of Health, Bethesda, Maryland.*)

The results of determinations of the growth hormones of several species of plants, native and exotic, including trees, by M. Kramer and K. Silberschmidt have recently appeared (*Arg. Inst. Biol. Dept. Def. San. Agric.* (São Paulo), November 1946, 17, Art. 7).

Extractions were made from segments of organs and sections of cambium by contacts with agar, and measurements were made by the conventional *Avena* coleoptile bending test. Relative concentrations from leaves, inflorescences, etc. with expected gradients from regions of origin to growing tracts in stems and elsewhere were found.

Since climatic, seasonal, and geographic features were taken into account, it seems necessary to correct the erroneous assumptions that my own results, expressed as dendrographic measurements of *Salix* and *Populus*, were obtained by experiments in Washington, and that I found the behavior of the two trees parallel.

Dendrographic records of *Populus* were made of one of seven species native to the region, under regulated irrigation, through several of the long, dry, hot summers characteristic of the Tucson area. Similar observations on *Salix lasiolepis* were made from 1922 to 1935 at Carmel, California, at which place this tree is native (Carnegie Institution of Washington, Publ. 462, 1936, 152–158). The maritime climate, with equable temperatures, humidity, and unvarying soil moisture and with the implied longer growing season, forms a basis for a dendrographic record widely different from that of *Populus* in the Arizona desert. The divergent features of the hydrostatic meshwork of the two trees might be expected to cause their divergent behavior if cultivated together in a neutral region (*Amer. J. Bot.*, 1946, **33**, 318–328). (D. T. MACDOUGAL, *R.F.D. #1, Box 170, Carmel, California.*)

Certain parts of the recent paper of Taplin and Bryan on the use of micronized therapeutic agents by inhalation (*Science*, May 9, p. 502) merit comment.

(1) Taplin and Bryan indicate that their patients prefer the inhalation of penicillin dust to penicillin aerosol. It should be called to the attention of readers of *Science* that penicillin dust having particles 1 μ in diameter, as reported by these authors, is also an aerosol. Suspension of fine, solid particles in a gas constitutes aerosols very commonly used both in industry and in medicine. For example, burning asthma powder produces an aerosol which has been known and used for many years in the therapy of asthma.

(2) The arguments advanced by Taplin and Bryan on the advantages of administering penicillin and other antibiotics as fine powders 1 μ in radius are not necessarily correct. The mass of a particle 1 μ in radius is proportional to the cube of the radius. Assuming that the particle is 100 per cent penicillin, the mass is proportional to 1.0, or equal to 1 mass unit. The writer has utilized penicillin dissolved in water containing approximately 1,000,000 units/cc. with the DeVilbiss No. 640 nebulizer. With this nebulizer most of the dose is administered in particles from 1 to 2 μ in radius (*Ann. Allergy*, 1946, **4**, 440). It is evident that particles 1 μ in radius will have approximately 60 per cent of the mass of the liquid particle as penicillin, or each particle will contain approximately 0.6 mass unit. This is somewhat, but not much, less than the solid particles of the aerosol of Taplin and Bryan. However, this difference is more than compensated by the presence of many particles reaching 2 μ in radius. The dose of penicillin in these particles is 60 per cent of $(2.0)^3$ or 4.8 mass units of penicillin per particle. This is more than four times the amount of penicillin per particle of solid penicillin in a penicillin dust having particles 1 μ in radius.

(3) The loss of penicillin dust by deposit in the mouth and upper respiratory tract is not described.

In view of (a) the simplicity of using penicillin dissolved in a liquid, (b) the availability of ordinary commercial nebulizers, and (c) the difficulty of maintaining penicillin particles without aggregation in tropical storage, it is believed that, for the present, the use of penicillin aerosols in the form of liquid droplets is to be recommended for routine procedures. (HAROLD A. ABRAMSON, *The Biological Laboratory, Cold Spring Harbor, New York.*)

TECHNICAL PAPERS

DDT for Powder-Post Beetle Control in Bamboo

HAROLD K. PLANK

Federal Experiment Station, Mayaguez, Puerto Rico

Scarcity of Eastern Hemisphere bamboo resulting from the war and continued shipping difficulties has created a rising interest in bamboo produced in the Western Hemisphere. About 30 species and varieties, comprising probably the largest collection of bamboo in this part of the world, have been introduced into Puerto Rico by the Federal Experiment Station in the 45 years since its establishment in Mayaguez. A number of these species have shown themselves to be well adapted to local conditions, and culms are now available in commercial quantities in Puerto Rico or other parts of the Western Hemisphere. However, the main limiting factor here, as elsewhere, in the utilization of these species has been the infestation of the dry culms by the widely distributed bamboo powder-post beetle (*Dinoderus minutus* F.).

Although none has yet been found to be immune, systematic testing over a period of years has shown that a number of species possess considerable natural resistance to this most troublesome and damaging pest. Much of this resistance was associated with lack of starch in the wood, and, where little starch was present, resistance was correlated with low moisture content and high specific gravity (*1*). The upper part of the culm was more resistant than the lower, and usually the older the culm, the greater was its total resistance to the beetle.

The best of various artificial methods to increase beetle resistance or to prevent attack either have been too cumbersome or too hazardous or have adversely affected the character of the wood for general use. Among some of the least cumbersome that have given good results have been harvesting culms of resistant ages and allowing freshly cut, untrimmed culms to dry or cure in the field. Recently, tests of the effect of "Bakelite-forcing" were conducted in cooperation with the Puerto Rico Development Company. While this impregnation of the wood with Bakelite did not entirely close the pores of the wood or change its reaction to the iodine starch test, it did harden the wood and imparted to it other commercially desirable qualities. Under the most severe conditions of infestation, pieces so treated remained immune to the beetle, while untreated wood of the same species and age was heavily attacked.

External application of DDT is proving more practicable than the foregoing and by far more effective than any other insecticidal treatment yet tried. In tests now in progress, one thorough brushing with a kerosene solution at the 5 per cent residual strength resulted in 94 per cent control of internodal infestation in highly susceptible, freshly harvested, one-year-old culms of *Bambusa vulgaris*. After treatment these culms were held in open storage away from rain and sun for 2½ months. Under the same conditions, a saturated solution of pentachlorophenol in kerosene and a 2 per cent solution of sodium pentachlorophenate in water plus 2 per cent of wettable sulfur produced 3 and 6 per cent control, respectively. Most of the few beetle holes in the DDT-treated culms were shallow. No internal infestation had developed that could be detected without splitting, while in the check and other treatments many culms were completely riddled. Heavy crystallization of DDT persisted on most of the internodes, and no living beetles (but many dead ones) were seen about the nodes where side branches had been removed. The practically colorless DDT solution did not discolor the wood or otherwise perceptibly affect its quality.

In a previous experiment freshly harvested wood was protected from beetle attack in a naturally ventilated cage for 6 months while air-drying to a moisture content of about 16 per cent. This treatment reduced infestation more than 83 per cent, indicating, with the results from field curing, that if protection against infestation can be provided for the first several months after harvest, the wood will increase considerably in beetle resistance.

From the foregoing tests it appears that DDT will supply this early protection and any that may be needed thereafter.

Reference

1. ————————. *P. R.* (Mayaguez) *fed. exp. Sta. Rep.*, 1944, 1945, p. 33.

Physiological Availability of Iodine in Dithymol Diiodide

R. R. BALDWIN, R. THIESSEN, JR., and E. E. MCINROY

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The insolubility of dithymol diiodide in water and brine and its chemical stability confer upon this compound distinct advantages over potassium iodide as an agent for iodizing salt blocks for cattle feeding. By means of radioactive iodine it has been shown that the iodine of dithymol diiodide is physiologically available to the thyroid of the albino rat.

Although a great many compounds of iodine have been tested with or without the use of radioactive iodine, there is apparently no experimental evidence that the iodine in dithymol diiodide in physiologically available. Dithymol diiodide is easy to synthesize and is commercially available. The material is sold under a number of trade names, including aristol, iodothymol, thymodin, thymol iodide, and others. Although the formula for dithymol diiodide is usually given as $(C_6H_2 \cdot CH_3 \cdot OI \cdot C_3H_7)_2$, with a molecular weight of 550.03, there is still some uncertainty as to just how the iodine is bound. In 1918 Bougault proposed a formula in which the iodine was connected directly to an aromatic carbon in place of the hypoiodite type of linkage; and the two thymol molecules were

linked through the OH groups, thus explaining the stability of the compound and the suppression of the phenol function (*1*). In 1935, Leclercq, in reviewing the tests and assays for dithymol diiodide, recommended the formula of Bougault as correct (*3*). If the iodine in dithymol diiodide is bound directly to the phenolic ring, there is some similarity between the compound and thyroxine of the thyroid. Joliot has already shown that thyroxine administered to rabbits was dissociated in the body, as evidenced by the subsequent formation of diiodotyrosine and ionic iodine (*2*).

In order to determine the physiological fate of iodine in dithymol diiodide, the compound was synthesized using I^{131} obtained from the Radioactivity Center at the Massachusetts Institute of Technology. The compound was prepared and fed to albino rats as described below. Various organs were then tested for radioactivity, which was followed by means of a Geiger-Müller counter and by radioautographs. The latter method requires no special equipment, although at best, the results are only semiquantitative.

Using the method of preparation described in the Merck Index (5th ed.), radioactive dithymol diiodide was prepared from 50 mg. of potassium iodide containing 1 millicurie of I^{131}. The product which was obtained as a light red-brown precipitate was washed free of iodide ions and dried over P_2O_5.

Iodized salt for cattle blocks usually contains 0.007 per cent iodine; consequently, dithymol diiodide corresponding to this amount of iodine was thoroughly mixed with 100 mg. of tricalcium phosphate and then added to 10 grams of iodine-free salt. The tricalcium phosphate is generally used for the dispersion of iodine compounds in salt. The iodized salt was then ready for incorporation in a normal diet. A second batch of salt was prepared in which this iodine content was 100 times the normal amount. The remaining dithymol diiodide was made into a water slurry of 10 mg./ml. to be administered orally by syringe to albino rats.

The diet fed to the rats in these experiments had the following composition: corn meal, 33 per cent; oat flour, 33 per cent; skim milk powder, 25 per cent; dried brewer's yeast, 3 per cent; Mazola oil, 5 per cent; and salt (iodized with the dithymol diiodide), 1 per cent.

Diet #1 contained salt with the normal amount of iodine (0.007 per cent). Diet #2 contained salt with 100 times the normal amount of iodine (0.7 per cent). The first pair of rats were starved for 24 hours and then given diet #1. Both rats in this pair weighed 450 grams, and both ate approximately 50 grams of feed before they were sacrificed at the end of 36 hours.

A similar procedure was followed with the second pair of rats, which were fed the iodine-enriched diet #2. These rats also consumed approximately 50 grams of feed before they were sacrificed at the end of 36 hours.

A third pair of rats were fed a normal diet, but each was given by syringe three oral administrations of $\frac{1}{3}$ cc. each of the suspension of dithymol diiodide in water.

At the end of the 36-hour feeding period the thyroid, kidney, spleen, and liver were removed from each rat, fixed in a 10 per cent solution of formaldehyde for 2 hours, washed in 95 per cent and in absolute alcohol, and allowed to dry. Radioautographs of all the organs were made by pressing them against an Agfa no-screen X-ray film contained in a black, lightproof envelope, the beta and gamma rays emitted by the radioactive iodine, if present, exposing the film. In such a process, a total of approximately 2,000,000 beta particles/cm.^{2} are required to "expose" the film. The results are best seen in the accompanying photographs in which the thyroids badly overexposed the films; in identical exposure times the kidney, spleen, and liver produced no exposure whatsoever.

In Fig. 1A, the radioautograph of a few minute specks of the freshly synthesized dithymol diiodide, there is evidence that the radioactive iodine had combined with the thymol, since the product had been washed thoroughly to remove all soluble iodine or iodides.

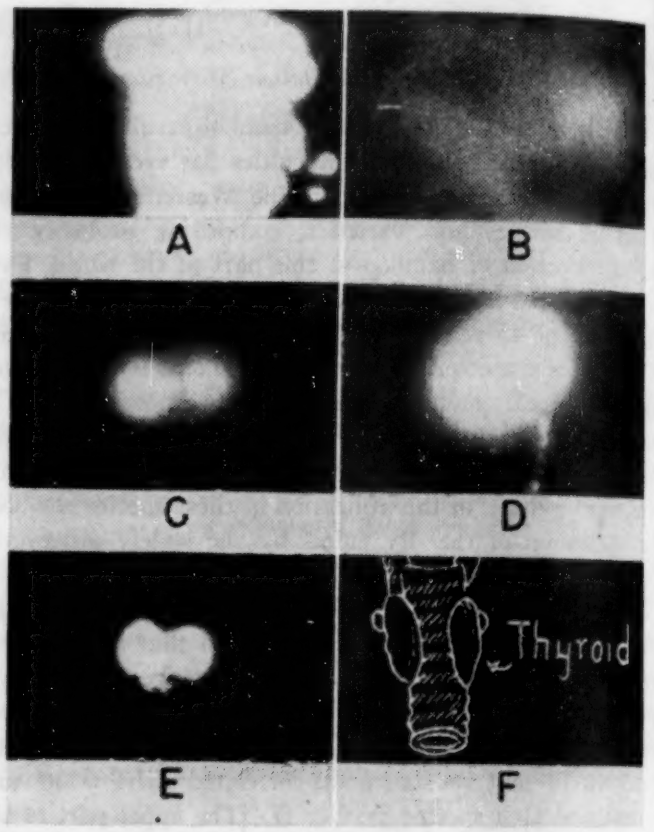

FIG. 1. Radioautographs and diagram of thyroid of albino rat: A, radioactive dithymol diiodide; B, rat diet; C, thyroid, rat #1; D, thyroid, rat #3; E, thyroid, rat #5; F, diagram thyroid, esophagus 2× actual size.

Fig. 1B shows the rat diet after the admixture of the salt containing the radioactive dithymol diiodide. The picture was taken to verify the fact that the radioactivity was evenly distributed throughout the diet by the mixing procedure used.

Fig. 1C is the radioautograph of the thyroid from one of the rats fed the diet containing the normal amount of iodine. The picture was obtained by cutting lengthwise the portion of the esophagus holding the thyroid glands and flattening the tissue against the enveloped film with a microscope slide. The radioactivity had very evidently accumulated in the thyroid.

From radioautographs of the various organs, plus those of the urine and feces, it was estimated that from 25 to 50 per cent of the iodine consumed had concentrated in the thyroid. The radioautographs shown in Fig. 1D and E were obtained in a similar manner, using the thyroids from the second and third pair of rats, which, respectively, had been fed the iodine-rich diet and had been given the dithymol diiodide slurry orally.

The fact that the thyroids of rats given the diet with 100 times the normal amount of iodine accumulated more iodine than those of the rats given much larger doses orally by syringe bears further investigation. The rats given dithymol diiodide by syringe excreted a greater percentage of the material in the feces than did the others. Some radioactivity was found in the

feces as well as the urine of all the rats consuming dithymol diiodide.

The radioautographs afford graphic evidence that the iodine in the water-insoluble dithymol diiodide is physiologically available to the thyroid of the albino rat.

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Plasma L-Methionine Levels Following Intravenous Administration in Humans[1]

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In connection with a study of amino acid metabolism in hepatic disease the observations here reported have been made on 11 normal human male subjects used as controls.

Methionine determinations were made by a microbiological method using plasma from heparinized blood. Removal of proteins from the plasma was accomplished by the following method, which avoids the use of heavy metal precipitants. To 1 volume of plasma in a 15-cc. centrifuge tube was added 1 volume of water and the tube placed for 1–2 minutes in a boiling water bath. One drop of 5 per cent acetic acid per cc. of plasma originally taken was then added and the contents of the tube thoroughly mixed, the tube remaining in the water bath for approximately 3 additional minutes. The tube was then centrifuged and a water-clear supernatant decanted for assay. The addition of tungstic acid precipitant to such a filtrate produces a very faint additional turbidity, indicating that removal of protein by the heating procedure was essentially as complete as that obtained with the tungstic acid precipitant.

Microbiological assay of the methionine in these filtrates was carried out with *Leuconostoc mesenteroides* P-60 in a medium in which an oxidized gelatin hydrolysate supplemented with tyrosine, tryptophane, and cystine served as the amino acid source. Methionine in the hydrolysate was completely removed, as evidenced by low blanks, by oxidation with 30 per cent hydrogen peroxide, using a method previously reported for the treatment of peptone (*2*). The response to added increments of methionine was equivalent to that reported for this organism by other workers.

Following a 12-hour fast a blood sample was drawn for determination of the level of plasma methionine. Fifty cc. of a 3 per cent solution of DL-methionine[2] was then injected intravenously over a 5-minute period, blood samples being drawn 15, 30, 60, 120, and 180 minutes after the injection. Methionine determinations in the urine excreted during the test period as well as during the 12 hours preceding the test were also made. In several cases urine samples to correspond to the periods when blood was drawn were also collected and analyzed.

The character of the variation in plasma methionine concentration after the intravenous injection is illustrated by the typical curve shown in Fig. 1. It is apparent that there

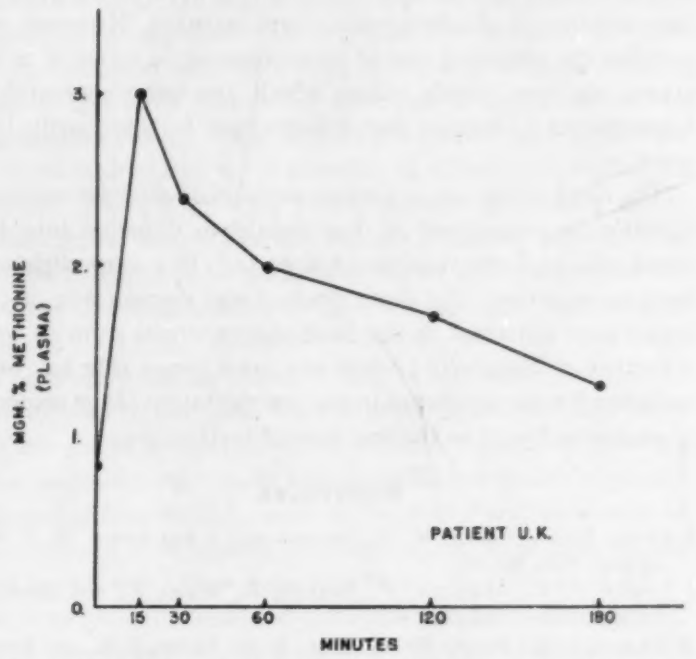

Fig. 1. Rate of disappearance of intravenously administered methionine in normal young adult.

was a sharp rise immediately following the injection which decreased to lower levels rapidly during the first 30 minutes and then much more slowly during the subsequent periods. In no case did the plasma level return to the previous fasting value in the 3-hour period of observation. In the entire series of 11 normal individuals, considerable variation in the absolute values for the various points on the curve were observed. The fasting levels ranged from 0.46 to 1.48 mg./100 cc. with an average of 0.85 ± .09. The observed "peak" value (at 15 minutes) ranged from 2.06 to 4.44 mg./100 cc., and the decrease in methionine concentration between 30 and 180 minutes varied from 0.82 to 1.36, except for a value of 2.14 in one case. Calculating the hourly rate of disappearance of methionine in the plasma from the 30- to the 180-minute period gave values ranging from 0.33 to 0.54 mg./100 cc./hour with an average of 0.41 ± .03, with the exception of the one case mentioned (not included in the average), in which a figure of 0.85 was obtained.

The excretion of methionine was most rapid during the first 15–30 minutes, when the blood levels were highest, but the amount excreted at any time was quite low when compared with the original quantities administered. For the entire 3-hour postinjection period of observation only 1.6–6.5 mg. of methionine were excreted. Fasting excretion values of approximately 0.1 mg./hour were uniformly observed. Thus, it is apparent that excretion accounted for the disappearance from the plasma of only a negligible portion of the 750 mg. of the L isomer administered, and that at these plasma levels no evidence of a limiting rate of renal tubular reabsorption for methionine was observed. This is in accord with the observations on dogs reported by Wright, *et al.* (*3*).

In view of the report of Dunn, *et al.* (*1*) on the response of various lactobacilli to the isomers of methionine, these assays as carried out with *Leuconostoc mesenteroides* P-60 are in-

[1] This work has been performed under a grant from the Office of Naval Research.

[2] The DL-methionine used in these experiments was supplied by Mead Johnson Co. through the courtesy of Dr. Warren Cox.

terpreted as measuring only the L isomer. Further study of this problem using *Lactobacillus fermenti* 36, which responds to both isomers, is in progress.

It will be noted that a fixed test dose of methionine was employed throughout all these experiments, regardless of variation in body size, and this probably accounts in part for the variation in absolute values here reported. However, expressing the observed rate of disappearance in terms of milligrams per hour yields values which are quite comparable. Experiments with other test dosages may further clarify this point.

The rapid initial fall in plasma methionine after intravenous injection is interpreted as due mainly to diffusion into the blood cells and extravascular spaces and, to a very slight extent, to excretion. The more gradual and regular rate of disappearance apparent in the later stages would seem to be a reflection of metabolic phenomena, and hence this has been considered more significant in the interpretation of the response of various subjects to the test dose of methionine.

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Activation of Eggs by Oxidation-Reduction Indicators

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In a previous paper (*1*) the writer suggested that the mechanism of fertilization of eggs was dependent upon the production of the appropriate redox potential of the enzymes controlling oxidations in the egg.

In order to test this hypothesis further, eggs were placed in sea water containing redox dyes whose E_0' values at pH 7.0 ranged from +.195 to −.258, giving an rH from 20.5 to 5.2. These dyes included o-cresol indophenol, methylene blue, brilliant cresyl blue, indigo tetra-, tri-, di-, and monosulfonate, Janus green, and neutral red. The concentration of the dye varied from .002 to .0001 per cent. The marine eggs used were those of *Urechis caupo* and *Strongylocentrotus purpuratus*. Since the end of the season for these eggs prevented further experimentation, this preliminary report is made.

The freshly obtained eggs were placed in solutions of dye in sea water for various periods of time from 1 minute to 24 hours and then replaced in sea water. Crowding was avoided. Samples were taken out at intervals. Activation was observed chiefly when eggs had been exposed from 1 minute to 20 minutes in the dye solution. Activation depended at different times on temperature, time in the dye solution, and concentration of dye. By activation is meant here either the formation of a fertilization membrane or cleavage with or without the membrane. In the case of *S. purpuratus*, development progressed to the pluteus stage in from 1 to 2 per cent of the eggs, in *U. caupo*, to the trochophore stage in about 50 per cent of the eggs. In other cases only the fertilization membrane appeared, the 2-, 4-, 8- or more cell stage developed, or irregular division occurred. The maximum percentage of activation varied from 70 per cent in *Urechis* to 10 per cent in *S. purpuratus*. Toward the end of the season no activation was obtained. In all cases unfertilized controls were completely free from activated eggs, while fertilized controls showed from 90 to 100 per cent activation.

In the case of *S. purpuratus*, the best results were obtained with indigo monosulfonate, which has an rH of 8.7. The rH of the sperm of this sea urchin was found to be from 9.0 to 9.5. In the case of *Urechis*, methylene blue and indigo tetrasulfonate gave the best results. The rH values of these dyes are 14.4 and 12.1, respectively, while that of the sperm of *Urechis* was found to be between 13 and 14. These results show a remarkable agreement between the rH values of the activating dyes and the respective sperms. Neutral red produced some fertilization membranes in a few cases. O-cresol and Janus green showed no results. A few cases of activation were produced by some of the dyes in the middle range of rH values. Development in all cases was slower than that of eggs fertilized by sperm, and a smaller proportion developed. These facts were also found by J. Loeb (*2*) in his experiments on artificial parthenogenesis with salt solutions. In some cases unorganized division takes place, resembling that of growth in neoplasms.

It should be pointed out that the sulfonate dyes have long been considered not to penetrate living eggs. However, since they have an activating effect on eggs in these experiments, one must conclude that either they penetrate at least far enough to produce parthenogenesis or the process of fertilization is initiated as a surface effect.

This preliminary report shows definitely that there is a direct relation between the redox potential and the fertilization of eggs. Other factors which may be involved will be discussed elsewhere.

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Irreversible Differentiation in Certain Plant Cell Lineages

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One fundamental problem in the morphogenesis of multicellular plants and animals is the mechanism which produces cellular diversity, and various theories as to the principal causes of histological differentiation have been proposed. Weismann's original idea of a progressive sorting out of nuclear determinants cannot be accepted. Nuclear changes of mutational character apparently play only a minor role, and at present there is general agreement that the locus of differentiation must be the cytoplasm itself. There is some difference of opinion among biologists as to just how this is brought about. It is characteristic of multicellular plants that they respond more directly than animals to influences from the outside; their cells, both in normal and regenerative ontogeny, preserve a high degree of totipotency, and, unless they have become

very specialized or possess aged cell walls, they differentiate, dedifferentiate, and redifferentiate in relation to their position and to factors of both the internal and external environment (*3, 9*). The specific character of animal cells, on the other hand, is often determined very early, and it is maintained in non-specific environments such as tissue cultures; if dividing, such cells may "breed true"—that is, produce only their own type. Botanists have thus come to regard the environment as a factor of major importance in many phases of histological differentiation, and much of the work has therefore been concerned with environmental modifications and effects on the cells. Zoologists, in several recent discussions, have developed a principle which might provide an understanding of the phenomenon of determination and stabilization of specific cellular differentiation in the organism. This assumes the presence in the cytoplasm of determinants genic in nature—the plasmagenes—which would account for the persistence of a particular type of cell character. It has been suggested that such plasmagenes are replicas or partial replicas of nuclear genes, nucleoprotein in nature, the activity and competition of which are subject to selection and mutational modification under the influence of variable local conditions and nuclear products. The capacity of autonomous, persisting duplication of such entities forms the basis for the transmission of specific cellular differences along cell lineages in somatic differentiation (cf. *11, 12*). Plasmagenes seem to bear close relation to viruses (cf. *6*) as to origin and chemistry, and it has been suggested that they are capable of being transmitted by grafting (*2*). Cytoplasmic inheritance is known in plants and has been demonstrated, for instance, for visible cytoplasmic constituents such as plastids (e.g. *7*), but there has been little evidence of persistence of cellular character in somatic cell lineages such as described for animals. The following observations, however, suggest that similar phenomena occur in plants which may serve as a basis for further work in this direction.

In the seedling and mature plant of *Ricinus communis* various kinds of cells (idioblasts) occur, notably those containing calcium oxalate and secretory cells whose contents give the reactions of unsaturated fats and tannins. A general survey of the distribution of both crystal and secretory cells was given by Scott (*8*). In some varieties of *Ricinus* the latter develop a natural red pigment (*1*). In the stem they are found in epidermis and ground parenchyma, especially of the pith. The writer has observed that the initials of these secretory cells are differentiated from cells of the ground tissue during early development. Their earliest appearance may be noted within the small-celled meristematic cone of the growing point itself, and they can be clearly seen at the level of the nodes of even the youngest portion of the stem. Once differentiated, they continue to divide and give rise only to secretory cells, which finally form long, vertical rows, one or several cells wide, among the ordinary cells of the ground parenchyma. In addition, new secretory cell initials are being differentiated here and there from larger and older ground parenchyma cells which develop in a manner analogous to those formed in the apical meristem. Between secretory cells in different parts of the plant some differences in the microchemical reactions were noted; in the red varieties, for example, the pigment does not appear in the youngest cells, but in those at some distance from the apex. Internodes were wounded by lateral cuts in both the youngest and fully differentiated older region of the stem, and a wound meristem was formed through cortical and pith parenchyma in which both parenchyma and secretory cells divided vigorously. The secretory cells, wherever present, produced only secretory cells. Thus, neither active cell division and growth nor altered position at the surface of the wound meristem had an effect on their anatomical and physiological character.

In other species of plants there occur various kinds of early differentiated idioblasts—for example, the so-called oil cells, tannin cells, and cells containing crystals of calcium oxalate. Cells of this kind were never observed to dedifferentiate in regenerating tissues. Some retain for a considerable time their power of multiplication; in air roots of *Cissus gongylodes*, for example, near the growing point, raphide cell initials divide several times, giving rise to rows consisting of crystal cells. Additional evidence as to the stability of cell character of the secretory cells in *Ricinus* and other similar cells might well be obtained from tissue cultures.

These observations indicate that in the differentiation of plant tissues certain cells become determined relatively early in their character and give rise subsequently to cells of the same character only, even under conditions which normally induce dedifferentiation, such as wounding and alteration of their correlative relations. The majority of plant cells do not react in this way. They remain, if they stay reactive at all, in a more or less undetermined state in which their development can be tipped one way or another under the selective control of the environment; cells can often be induced to dedifferentiate, or to differentiate in a specific fashion corresponding with their position and the particular state of reactivity which they possess at a given time and locus (*3*).

One may thus tentatively suggest that the behavior of the secretory cells in *Ricinus* involves a change in their cytoplasmic system in which control exerted by determinants in the nature of plasmagenes plays a role. The result is both a limitation of cellular totipotency and stabilization of cellular character in somatic differentiation. The cytological mechanism by which determinants of this kind come into control in definite cells is at present a matter of conjecture. It may well be that polarity plays a part. At the cell division which precedes the differentiation of a secretory cell initial, an unequal distribution of cytoplasmic material might take place, resulting in a differential concentration of determinants or determinant-precursors in the two daughter cells. Such division would be differential, though not necessarily visibly so. A number of typically differential divisions, as a result of which the two daughter cells become different in size, cytonuclear ratio, meristematic condition, and subsequently in their structure have been described previously (root hair cell, trichosclereid, and hypodermal passage cell division, *5, 10*). In each of these cases the ultimate fate of the two daughter cells is very unequal, although both cells are side by side and probably under identical environmental conditions. In *Ricinus* the capacity of cells to divide differentially obviously extends over a considerable time, since they occur both in the young and old parts of the stem and in the secondary tissue formed after wounding.

The complex patterns of structural differentiation and physiological reactivity which the observer encounters everywhere appear to be the outcome of most varied processes and forces. Some structural changes in the cells can be correlated rather directly with physicochemical factors in external and internal environment, as in the case of cells located at surfaces

(*3*). Doubtless polarity, which is basic in the elaboration of many patterns of growth and differentiation in both unicellular and multicellular forms (*4*), is another factor. It may control the orderly distribution of cytoplasmic material and various substances. Finally, as in the cells here described, there may be specific, qualitative alterations in the reactivity systems of the cells, due to permanent changes in the genetic make-up of the cytoplasm itself.

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Separate Localization in the Medulla Oblongata of the Vagal Inspiratory and Expiratory Reflex Centers

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Stimulation of the afferent vagus nerve acts upon respiration in two different ways. With low stimulus frequency corresponding to the low rate of afferent impulses elicited by lung deflation or small lung volume, the effect on respiratory posture and breathing movements is mainly inspiratory, whereas with higher stimulation rates corresponding to the higher afferent impulse frequencies produced by lung inflation or great lung volume, breathing becomes predominantly expiratory. It must be emphasized, however, that there is no hard, clear-cut line between the low-rate inspiratory effect and the high-rate expiratory effect, and that they both exist simultaneously over a wide range of intermediate frequencies. Thus, within physiological limits, a dual control of respiration is accomplished by these two antagonistic vagal tendencies, inspiratory and expiratory, the former prevailing with a decrease, and the latter with an increase, of the frequency of centripetal impulses emerging from the pulmonary stretch receptors. From this statement it may be inferred that posture as well as movement of the respiratory effector system, which is mainly or even exclusively an inspiratory one, results at any moment of the breathing act from the combined influence of the two opposite vagal drives, excitatory and inhibitory. Perhaps only in the extreme conditions of the vagus nerve artificial stimulation, with adequately chosen rates and intensities of stimuli, may pure inspiratory or expiratory effects be obtained, appearing then as inspiratory or expiratory standstill of breathing.

In order to determine whether separate reflex centers for inspiratory and expiratory effects, respectively, can be distinguished at the level of the medulla oblongata, small circumscribed lesions have been made by means of nonstimulating high-frequency coagulation, in the region of the bulbar respiratory center. It was first observed that suitable lesions situated at a more cranial level can destroy only the expiratory drive without any weakening of the inspiratory one. On the other hand, a somewhat lower, *i.e.* more caudally located lesion, abolishes only the inspiratory component of the vagal respiratory reflex, leaving the expiratory effect intact. Thus, the existence of two different central pathways involved in vagal respiratory reflexes and corresponding to the two antagonistic reflex components has been proved and has later on found further and more detailed anatomical confirmation.

Selective elimination of either the inspiratory or expiratory effect of vagal stimulation demands a small destruction lying in the tractus solitarius, its nucleus, and the adjacent dorsal part of the lateral reticular formation. For the expiratory component, this critical lesion occupies the tractus solitarius system at a more cranial level, *i.e.* just caudal to the entrance of the vagal respiratory fibers. But this expiratory lesion does not interfere with all the descending fibers of the tractus solitarius, unless the inspiratory effect be also abolished, and "central vagotomy" ensues. Some lateral portion of the solitary system, including mainly tractus fibers, must be spared, which seems to indicate that impulses mediating the inspiratory effect are conveyed in those descending fibers. For the inspiratory component of the vagal respiratory reflex, the region responsible lies in the caudal part of the tractus solitarius system, at a distance of about 2 or 3 mm. This inspiratory lesion is much less critical than the expiratory one, involving the entire transverse section of the solitary complex.

The related experimental findings lead to the following anatomical considerations: All the afferent respiratory fibers of the vagus nerve enter the medulla oblongata through the cranial portion of the vagus root and join the tractus solitarius, running down into the latter, but leaving it again at a higher level to form the expiratory and, at a lower level, the inspiratory reflex pathways. Assuming that these fibers leaving the tractus solitarius terminate mostly in its nucleus and the adjacent part of the reticular formation, where they come in synaptic contact with internuncial neurones, the column of gray matter accompanying the tractus solitarius may be considered as the locus proper of the vagal respiratory reflex centers. It is worth noting that central lesions affecting one or the other of the two antagonistic components of vagal respiratory control include besides, or perhaps rather than the tractus solitarius itself, these adjoining cellular structures. There is reason to believe that the above-described selective interruptions of the intrabulbar reflex pathways are located at those places where afferent fibers, or fiber collaterals, converge toward an interneuronic relay station, and that no selection would be obtained by the destruction of fiber tracts only. The same may be true with regard to the continuing fiber pathways, whether they be regarded as further intracentral connections of the afferent system or as the descending efferent paths of the "reflex arc." In this latter case, which appears the most likely, the selective suppression of central reflex transmission would thus be located at the origin of the internuncial neurones acting on the respiratory motoneurones of the spinal level. Definite conclusions, however, will have to be postponed until further anatomical and experimental studies have been made.

As far as our present state of knowledge permits inferences concerning the central mechanism and structural arrangement

underlying the vagal respiratory reflexes, we may consider the nuclear column adjoining the tractus solitarius as the common interneurone pool for these reflexes, with a cranial part of expiratory, *i.e.* inspiratory-inhibitory, and a caudal part of inspiratory-excitatory, internuncial neurones. It is suggested that these solitary interneurones are controlling the inspiratory motoneurones directly, in an excitatory as well as in an inhibitory way. But a higher reflex integration involving the autonomous divisions of the respiratory center also exists, for it alone could account for some particular features of the vagal control of breathing.

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A New Disease of the Variegated Cutworm, *Peridroma margaritosa* (Haw.)

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In February 1947 we received from F. H. Wymore, of the Union Oil Company insectary at Anaheim, California, several diseased specimens of the variegated cutworm, *Peridroma margaritosa* (Haw.). This species was being reared in a small insectary room to obtain eggs on which ovicidal tests were being run. In the accompanying correspondence Wymore wrote that the disease had been causing an extremely heavy mortality among the older caterpillar population for a period of about four or five weeks. Only a small percentage of the caterpillars ever reached pupation, and only about 50 per cent of the eggs produced by the moths which later emerged proved fertile.

Microscopic examination of the cutworms revealed the presence of bacteria in the blood and a pathology of the fat tissues characterized by the presence of large numbers of small, granular inclusions in the cytoplasm of the fat cells. The nuclei of the fat cells were usually hypertrophied and in a state of degeneration. The bacteria, possibly secondary invaders, were gram-negative small rods which, for the most part, did not ferment lactose.

Additional diseased as well as normal caterpillars were kindly furnished by Mr. Wymore, and with this material infection experiments were conducted which provided the following information.

Healthy variegated cutworms may be infected by direct inoculation into the body cavity, and through the mouth by means of contaminated food. (There is also some evidence that the infecting agent may pass from one generation to the next through the egg.) After two or three days the infected insects begin to eat less food; they may remain slightly smaller in size than normally developing insects, have a somewhat languid appearance, and, in the cases so far observed, usually die before pupating. The fragility of the integument and the marked internal liquefaction of tissues, so characteristic of polyhedroses, is absent. The larvae are flaccid, but the body wall remains relatively firm.

Upon dissecting a diseased larva, one immediately notices an opaque whiteness of the fat tissue which may be solidly white or, in lighter infections, of the normally clear appearance except that it is flecked with opaque, white areas. Under a compound microscope these opaque areas may be seen to consist of nodules of hypertrophied fat cells filled with large numbers of minute (0.4–0.6 μ) granules. Suspended in an ordinary wet mount the infected cells break down rather rapidly, liberating the contained granules until eventually the entire preparation consists of millions of discrete granules together with some cellular debris. The granular inclusions are nearly spherical, are not as refringent as are polyhedral bodies, possess a very slight cream coloration when seen *en masse*, and are readily visible with an ordinary light microscope. When ordinary stained preparations are attempted, these bodies lose much of their distinct granular aspect and appear as lightly stained amorphous particles, frequently coalesced. They do not have the characteristic attributes of bacteria and are not cultivable on the usual bacteriological media.

Sections of the diseased cutworms show a characteristic histopathology of the fat tissue. The nuclei of the fat cells appear either as considerably enlarged, densely staining masses or as disintegrated particles of chromatin material scattered over an area which represented the originally hypertrophied nucleus. The cytoplasm of these cells is packed with large numbers of the granular inclusion bodies. Sometimes the cell membranes are broken down so that the contents of several cells are enclosed in a single area the size of several cells.

The exact nature of the granular inclusions has not been determined. Whether or not they themselves represent the causative agent, probably a virus or agglomerates of a virus, or a peculiar type of granular degeneration, is not known. A few filtration experiments have shown the filtrates from Mandler filters of coarse porosity to be infectious but, so far, not those from Mandler filters of medium or fine porosity. The granular inclusions characteristic of this disease have points of similarity with those described by Paillot (*2*) in the case of *pseudograsserie 1* of another cutworm, *Euxoa segetum* Schiff., and possibly with those briefly described by Graham (*1*) in the case of a disease of the spruce budworm, *Archips fumiferana* (Clem.). It is possible that these agents are representatives of a distinct group of virus diseases of insects, the other two groups being the well-known polyhedroses and those infections (e.g. sacbrood) characterized by the absence of inclusion bodies of any kind.

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IN THE LABORATORY

An Interval-Timing, Automatically Resetting Switch to Operate After Any Given Number of Counts

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Two commercially available pieces of apparatus were inserted into a circuit that automatically rewinds a camera every time a given number of frames is exposed, thus preventing the tension of the camera's spring-drive mechanism from becoming so low as to result in erratic performance of the shutter. The frames are counted by causing the solenoid operating the single-frame plunger on the camera to close a switch at each stroke, thereby actuating an electrically operated counter[1]. The counter is modified[2] by removing all but the first two wheels and sliding onto its shaft a brass wheel arranged to turn in unison with the second digit wheel. Two electrical contacts are made to the circumference of the brass wheel. One is a permanently closed wiping contact, and the other is interrupted by insulating segments so spaced that contact is made every 180°, or twice in each revolution of the second digit wheel, *i.e.* once every 50 counts.

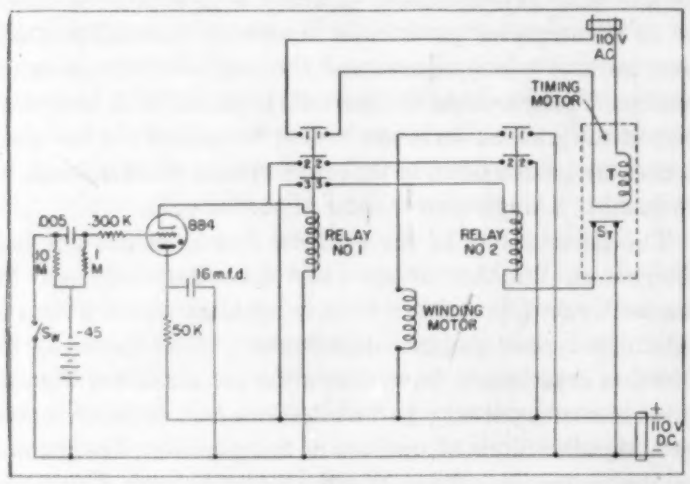

FIG. 1

On every 50th count, therefore, a second switching circuit is closed (at the point shown as S_w, Fig. 1). This simultaneously energizes the camera winding motor and a timing motor (synchronous)[3] set to cut both itself and the winding motor off after a predetermined interval (15 seconds in this case) sufficient to rewind the camera mechanism enough to restore the original spring tension in the camera drive. The synchronous timing motor has a magnetic clutch bringing the gear train of the timer into place when the motor is energized. When the clutch is demagnetized upon opening the motor circuit, a spring disengages the gear train, allowing another spring to reset the time-delay mechanism. To make the timing motor circuit independent of the duration of closure of the counter contact, which would vary with exposure rate and would remain closed if the counter were stopped on the 50th or 100th frame, the circuit from the counter is arranged so that, when closed, it produces only a short triggering pulse firing a thyratron. The output of the thyratron closes relay #1, and relay #2 is closed through contact 3 of relay #1, switch S_t in the timing motor being normally closed. Closure of contacts 2 on both relays completes a holding circuit to keep the relays closed after the pulse from the thyratron has ended. Contact 1, relay #1, starts the a-c timing motor. Contact 1, relay #2, starts the camera winding motor. After 15 seconds the timing motor opens switch S_t, which breaks the holding circuit and allows both relays to open, removing the voltages from timing and winding motors. The timing motor then resets itself, and conditions are returned to the original state.

The application described prevents the spring drive on our camera from running down enough to produce erratic performance of the shutter, which has to be maintained in synchronization with recurring single sweeps of the cathode-ray beam being photographed. Other related timing problems could be solved in this fashion by suitable small modifications of the counter and the choice of a timing motor of appropriate range.

[1] Manufactured by Gorrell & Gorrell, New Jersey.

[2] We wish to thank Gracient Eidt, school machinist, for his cooperation in constructing the modified counter.

[3] Manufactured by Haydon Manufacturing Company, Connecticut.

Simplified Techniques for Inoculating Chick Embryos and a Means of Avoiding Egg White in Vaccines[1]

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Most of the current techniques for inoculating chick embryos, as, for instance, those outlined in the report by Beveridge and Burnet (*1*), involve the use of a dental drill, an instrument seldom available except in specially equipped laboratories. The techniques described below render the drill unnecessary and also have the advantage of avoiding nonspecific lesions which drilling often causes on the chorioallantois.

Chorioallantoic inoculation. The eggs are candled, and the margin of the air space is marked on the shell in pencil on the side where the chorioallantois is best developed. The shell around this area is disinfected with 1/100 Zephiran or other suitable disinfectant. Using a pair of round, pointed forceps, a hole is made in the shell over the air space, a few millimeters from its margin. The shell is jabbed with the points of the

[1] Work carried out while the author was working under a grant by the Australian National Health and Medical Research Council as a guest worker at the Pasteur Institute.

forceps until it and the attached membrane are breached, and then the hole is carefully enlarged until it is roughly 1 cm. long and 3–4 mm. wide, running parallel with the margin of the air space. Next, the shell without the attached shell membrane is broken away for 3–4 mm. beyond the margin of the air space—that is, over the chorioallantois. In doing this, care must be taken to lift the fragments of shell slowly outwards with the forceps and not to allow them to hinge back and pierce the chorioallantois. The exposed outer layer of shell membrane is then torn away, and the inner layer of shell membrane is found to have a fold about 1 mm. wide marking the margin of the air space. A fine pair of forceps is used to tear the shell membrane along this fold. Up to this stage of the operation the egg is held in the left hand in an approximately horizontal position; it is now tilted with the air space downward. With 11-day embryos the chorioallantois usually falls readily, giving an artificial air space in the same position as with the standard Burnet technique. With 12-day embryos it is usually necessary to tap the egg with the fingers to commence the separation of the chorioallantois from the shell membrane. When the separation commences, the egg is returned to a horizontal position. The inoculum is placed on the chorioallantois with a Pasteur pipette, the hole in the shell sealed with cellophane adhesive tape, and the egg incubated in a horizontal position.

Amniotic inoculation. After preliminary incubation with the air-space end uppermost, in most of the eggs the embryo is found close to the margin of the air space, which is essential with this technique. The eggs are candled and the hole commenced as for chorioallantois inoculation, but it is not extended beyond the margin of the air space. A sharp, pointed pair of forceps is thrust through shell membrane and chorioallantois, close to the margin of the air space, and the hole thus made extended by blunt dissection to about 1 cm. As the air enters, the embryo enclosed in the amnion is presented at the hole. It may be necessary to remove some of the shell membrane adhering to the chorioallantois. Sometimes an air bubble blocks the hole; this may be disposed of by touching it with a needle heated in the flame. The amnion is grasped with forceps and inoculated with a Pasteur pipette drawn to a fine point and beveled, or with a syringe and needle. The egg is sealed with cellophane adhesive tape and returned to an upright position for incubation.

Allantoic and yolk sac inoculations. The current technique in many laboratories is to pierce the shell with a needle, and it is mentioned here merely to complete the series of techniques not requiring a dental drill. The hole is made in the shell with a surgical needle mounted by driving it through a rubber bung, after which the standard techniques are followed.

Position of the egg during incubation. Although it is well known among embryologists that the position of the egg during incubation determines the position of the embryo within the egg, this fact does not appear to be generally known by virus workers.

After 4 days incubation the embryo often moves freely within the shell, rising immediately to the uppermost point as the egg is rotated. Between the 5th and 9th days movement is slower: if an egg lying horizontal is rotated 90°, the embryo and membranes rise to the top after several hours. Between the 10th and 12th days the position of the membranes becomes fixed, but the position of the embryo may still change to some extent if the egg is turned.

If eggs incubated horizontally for 6–9 days are turned 180° so that the embryo and membranes are on the lower side, about 25 per cent die overnight. On the other hand, among eggs that are not turned at all during incubation up to the 12th day I have observed very few deaths—no more than occurred in eggs turned slightly once or twice a day.

If eggs have been incubated in the horizontal position, it is often not easy to harvest the allantoic fluid because, on reflecting the membrane under the air space, one encounters yolk sac and egg white as well as the allantoic cavity. If an egg has been incubated with the air space down, it is impossible to harvest either allantoic fluid or the yolk sac via the air space, because under the membrane in the air space there is only egg white. The embryo will be located in the "sharp" end of the egg, and the egg white is always in the lowermost point.

When cultivating influenza virus for vaccine production by red cell concentration technique, it is especially desirable to have the embryo centered under the air space. Furthermore, unless it is in this position, inoculation via a hole in the air-space end of the egg will often fail to infect the allantoic cavity.

It is of considerable importance that vaccines produced from the developing egg should be free of egg white; therefore, for the production of vaccines from allantoic fluid, yolk sac, or embryos, the eggs should be incubated before and after inoculation in a nearly vertical position with the air space upwards. They may be inclined 30°–40° from the vertical and turned by tipping back and forth once or twice a day. The only advantage in turning in this way is that it results in a more symmetrical development of the chorioallantois and allantoic cavity. On the other hand, for inoculation on the chorioallantois it is somewhat of an advantage to have a large area of chorioallantois on one side of the egg, so the eggs are better not turned before this type of inoculation. For intracerebral inoculation or amniotic inoculation by the standard Burnet technique it is better to incubate eggs in a horizontal position before inoculation.

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Use of Trisodium Phosphate With Herbarium Material and Microfossils in Peat

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A brief article recommending the use of dilute aqueous solutions of trisodium phosphate for reclaiming dried zoological specimens (*1*) suggested the possibility of using the same technique for restoring herbarium specimens to a condition for sectioning or clearing. In one test, for example, two leaves and a twig of dried *Viburnum acerifolium* L. were placed in 25 cc. of the solution and kept in an oven at 60° C. for 2 hours. The leaves assumed the external appearance of fresh material (except for a slightly less brilliant green color) and approximately the natural flexibility, toughness, and turgidity of the fresh state. Free-hand sections of the leaves showed the par-

enchyma cells to be in a state approximating normal turgidity and the protoplasts with a distended, although not truly life-like, appearance. The chloroplasts of the mesophyll were distributed approximately as in the living condition. The twig also resumed its flexibility and turgidity. It was possible to cut free-hand sections of the twig with nearly the same ease as with fresh material; and the cells of the pith, wood parenchyma, and cork resembled very closely the forms of those in the living tissues.

Prolonged treatment is to be avoided; for after 18 hours at 60° C., or upon standing for several days at room temperature, certain tissues begin to show areas of brown discoloration (due presumably to the breakdown of chlorophyll and the diffusion of lignin derivatives). After 24 hours at 60° C., treated leaves become uniformly brown and begin to lose resiliency.

The success in restoring herbarium specimens led to the application of this method to the preparation of peats for analysis of microfossils. After trying concentrations which varied from 0.25 per cent to 10 per cent and temperatures ranging from 24° to 60° C., the best results again were achieved with 0.25–0.5 per cent solutions heated for 2 hours at 60° C. The peat sample is placed in a 15-cc. centrifuge tube, covered with approximately 10 times its volume of solution, and placed in the oven. If the peat has been stored in the wet condition, it can be gently broken up in the centrifuge tube with the tip of a camel's-hair brush before heating. If, however, the peat has been dried in storage, this operation is best delayed until the solution has reached 60° and has thoroughly moistened the peat. The addition of a wetting agent, e.g. Nacconol (National Aniline Company), to the solution accelerates the action on dried material. After heating, the material is twice washed with distilled water, centrifuged, and decanted. An amount of glycerine equal to the volume of the sediment is then added, and sufficient quantities are pipetted out to make slide mounts.

Although the trisodium phosphate preparation of peat samples has the disadvantage of removing very little of the materials which may tend to make the identification and counting of pollen and spores difficult, it seems desirable because it restores the sediment to a condition similar to its state when freshly deposited. The particulate matter is well deflocculated. Pollen, spores, fungal hyphae, trichomes, and most tissues of a more gross nature are re-expanded to approximately their normal shape in life. In addition to the re-expanding of the pollen grains, the exine layers appear to become turgid, so that characters such as the arcuate bands between pores of the *Alnus* grain, the hyaline bodies beneath the pore of the *Fagus* grain, and the "fingerprint" markings on the surface of the *Acer* grain stand out very clearly. The most delicate features of waxy excrescences on certain fern spores were entirely undamaged. The method causes no apparent change in the preserved diatoms, insect chitin, exoskeletons of planktonic crustacea, etc.

The study and identification of small fragments of tissues and microfossils other than pollen will prove to be of increasing significance in peat studies, particularly in contributing new lines of evidence concerning the biota and the ecological factors relating to particular strata or deposits. The use of the trisodium phosphate method is recommended as an aid in the study of this whole fossil biota of peats.

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Three-dimensional Graphs

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With respect to the construction of three-dimensional graphs (*1*), it has occurred to me that a simple procedure I have used for this purpose will be of interest. On a sheet of ordinary graph paper a base is laid out by drawing lines at angles of 45° from the horizontal. On this are plotted independent variables (x, y)

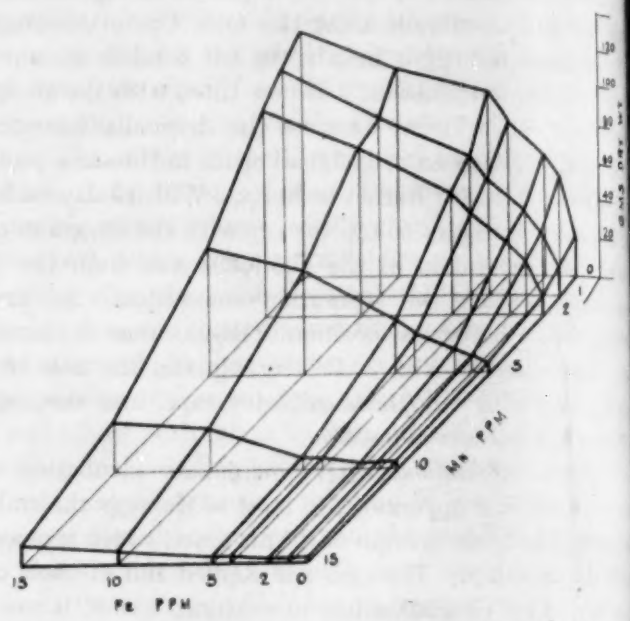

Fig. 1. Effect of simultaneous variation of manganese and iron on the total dry weight of bean plants.

while the dependent variable (z) is plotted on verticals from the base. Spaces on the graph paper serve for all three dimensions, and, if desirable, logarithmic values may be used. By connecting the points in two directions and to the base a solid figure is shown in perspective. The best effect is obtained if the graph is oriented so that the smaller values of z are in the fore-

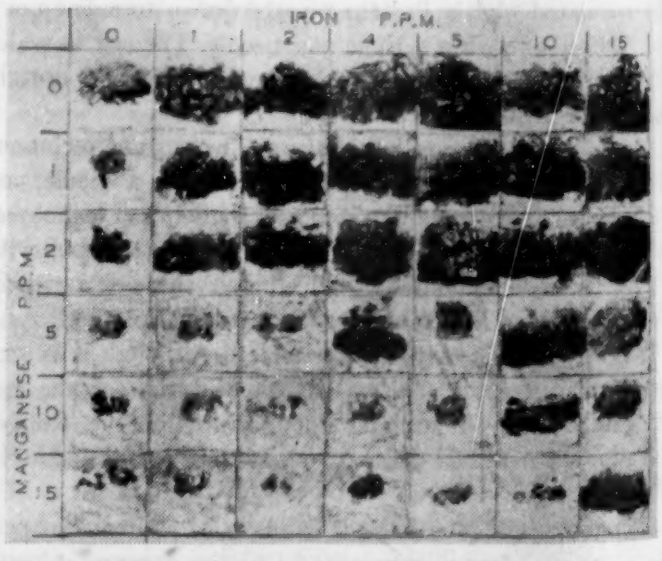

Fig. 2. Photographs of cultures of bean plants represented in Fig. 1.

ground. Heavier lines should be used for the "roof" and front and right "walls" to give the correct optical appearance. For publication the graph may be copied on tracing paper and photographed.

On Fig. 1, which was constructed as described above, are

shown the dry weights obtained by varying both the iron and the manganese concentration in a series of 42 solution cultures of bean plants (*2*), while Fig. 2 is made up of photographs of the same plants. Extreme toxicity of manganese in the absence of insufficient iron and the antidoting effect of iron are clearly shown.

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Penicillin as an Agent for Sterilization of Protozoan Cultures

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Cleveland (*1*) attempted to obtain sterile cultures of *Trichomonas* using bactericidal agents. He states that the search for efficient chemical agents for the sterilization of protozoan cultures "appears to be almost a hopeless undertaking" (p. 256). However, various chemicals have been used successfully upon protozoan cysts. Morgan's (*3*) success in obtaining sterile cultures of *Trichomonas* with the use of penicillin and streptomycin suggested the possibility of using these antibiotics as agents for the sterilization of free-living protozoa.

In the present investigation *Colpidium campylum* was used. Organisms from a wild culture were concentrated by centrifugation and were washed three times with sterile Hahnert's solution (*2*). A few drops of the washed concentrate were then added to a solution of sterile 3 per cent Difco proteose-peptone containing 5,000 units of penicillin[2]/cc. After being in the penicillin solution for 12 hours, the organisms were transferred through three successive washes of 3 per cent proteose-peptone. A drop containing organisms and culture fluid from the third wash was plated on nutrient agar. No bacterial growth was observed on any of the agar slants used in the 8 tests conducted. The colpidia were apparently uninjured by exposure for 12 hours to solutions containing 5,000 units of penicillin/cc.

It appears that this method may be used with success in obtaining sterile cultures of most protozoa. However, with each different species used, preliminary tests must be made to ascertain the length of time the organism will survive in a given concentration of penicillin. If the survival time is extremely short, lower concentrations should be used. Preliminary observations indicate that *Paramecium nucleatum* is killed in 12 hours in solutions containing 5,000 units of penicillin/cc., but remains in a vigorous condition for 5 hours in the same concentration.

The process described above does not require constant attention of the investigator, large numbers of organisms are recovered after the final wash, and the number of transfers is reduced to a minimum, thus reducing the possibility of contamination.

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[1] The author wishes to express his gratitude to C. G. Wilber for aid in the preparation of the manuscript.

[2] The penicillin used was supplied by Merck & Co., Inc.

A Monitoring Probe for Radiochemistry Laboratories[1]

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In order to detect contamination of equipment and to protect the health of workers in laboratories handling radioactive materials, it is necessary to have instruments capable of indicating small amounts of radiation at the working space and on the person and clothing of workers. Several excellent portable radiation meters are now on the market, but only the most recent ones are effective in detecting weak radiation, the older ones generally being designed for monitoring X-rays.

As Libby (*1*) points out, the isotopes emitting the least energetic radiation are among the most useful. By substituting a more sensitive GM tube for the one ordinarily furnished, older instruments easily may be changed to permit them to detect a fraction of these weak radiations large enough so that they may be of service in monitoring laboratories. Moreover, the housing for the GM tube described here permits using the tube at some distance from the meter, allowing more flexibility in monitoring and incidentally permitting any scaler to be used as a detector of contamination.

A thin-walled, silvered, self-quenching tube is mounted in a stainless-steel housing, provided with mesh-covered windows over the sensitive area of the tube. The use of stainless steel permits ready decontamination of the probe itself in case of contamination, a nitric acid wash being sufficient in most cases. Fig. 1 shows some of the constructional details of the

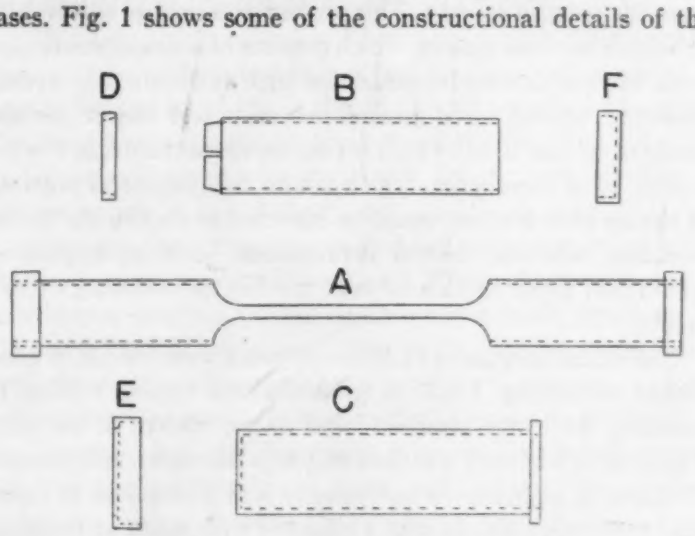

Fig. 1

probes used in this Laboratory. A, the body of the probe, is tubing, 10 inches long and 1 inch in diameter, which is attached to handle C by means of collar E. Tube B slides over A and can be secured in a position over the windows by tapered collar D. When not required in this position to protect the GM tube or to distinguish gamma from beta radiation, it is pushed back toward handle C. By making slide B $\frac{1}{16}$ inch thick, the original calibration (in R's/8-hour day) of a Herbach and Rademan Model GLR-200 Radiation Meter is sensibly unchanged when B covers the windows. With the slide open, the sensitivity of this meter is increased more than 10-fold for energetic radia-

[1] Research sponsored by the Office of Naval Research, Contract N-6 ori-47, Task Order No. 4.

tion, and the detection of weak radiation is made possible. Traces of C^{14}, for example, are distinctly indicated, although weaker radiation (*1*) is not detected.

By means of a suitable connector at the end of handle C the probe is attached to the meter or scaler with co-axial cable, up to 20 feet long. In the authors' experience, the high potential supplied by an AC-operated type radiation meter requires very little change in value to enable the new tube to work on its plateau (ca. 800 volts for commercial tubes of this type).

In one application, this probe was attached to a Herbach and Rademan meter to which, in turn, had been added a simple audioamplifier and loud-speaker, obviating the necessity of looking at the meter while testing for stray radioactivity. The frequency of occurrence of the audible clicks is a measure of the intensity of the radiation passing through the probe. In another application, the described probe was attached to a standard scaler of 64, where it worked equally well.

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Use of the Hydra for Pharmacological Study

Stata Norton and Edwin J. de Beer

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The hydra responds to touch by a withdrawal of its tentacle from the point of contact. This process presumably involves its primitive nervous system, which consists of a simple nerve network without a central organization such as a brain. The hydra, therefore, should have possibilities as a test object for the study of certain drugs which act on nerve mechanisms. For instance, local anesthetics, which act on the peripheral portions of the nervous system, would be expected to abolish the tactile response, whereas central depressants, such as hypnotics, would not. These ideas were confirmed in the following experiments.

Individual specimens of *Hydra oligactis* were placed in glass dishes containing 5 ml. of glass-distilled water. Within 15 minutes, the hydra attached itself to the bottom of the dish. The drug to be tested was then added to the water, and changes in shape, in spontaneous movements, and in response to vigorous tactile stimulations with a glass rod were noted at 1-minute intervals.

In agreement with the above postulates, it was found that each of the three local anesthetics tested (cocaine, procaine, and pontocaine) abolished the response to tactile stimulation; and, as was expected, the general hypnotics, Dial and Evipal, failed to inhibit this reaction. The local anesthetics also frequently caused the hydra to become detached from the dish. Perhaps this was a further manifestation of peripheral nerve depression. The abolition of tactile response by the local anesthetic was not due to the death of the hydra, for it was possible to restore the sense of touch by replacing the local anesthetic solution with fresh water.

Certain quantitative relationships were also observed for the local anesthetics. The minimum effective dilutions for pontocaine, cocaine, and procaine were, respectively, 1:25,000, 1:5,000, and 1:1,000. The drugs were therefore effective in the ratio 25:5:1, which is similar to that recorded for higher animals. Table 1 shows that the time required for the onset of tactile anesthesia increased as the concentration of cocaine decreased. A similar relationship was found for procaine. These results are again comparable to those obtained on common laboratory animals.

TABLE 1

Effect of Varying Concentrations of Cocaine on Time of Onset of Anesthesia in the Hydra

Concentration (mg./ml.)	Onset of anesthesia (min.)
0.2	Partial anesthesia
0.25	20
0.4	25
0.4	30
0.4	28
0.4	37
0.4	11
0.5	3
0.5	8
1.0	2
1.0	2
1.0	11
1.0	4
2.0	Disintegration

All of the drugs mentioned produced changes in the size and shape of the hydra. The local anesthetics regularly caused an initial contraction which was soon followed by a return to the original size. The only effect of the barbiturates was to produce a persistently shortened and thickened hydra.

The actions of certain other drugs on the hydra were also observed. The analgesic, morphine, which is believed to act centrally, produced no visible effect. Curare, after an initial contraction, produced great elongation, often to two or three times the original length. A tendency to form spirals or curls was noted. There was no loss of tactile sense or of spontaneous movements. Papaverine-treated hydrae first contracted and then regained normal size, but became rigid with complete loss of spontaneous movements, of response to touch, and of response to acetylcholine. The action of the latter drug by itself was limited to an initial contraction and was difficult to assess, since many things, *i.e.* salt solutions, cold, water movement, etc., caused brief contractions of the hydra. Although these may be qualitatively similar, the possibility remains that different drugs may produce contractions differing quantitatively in extent and duration.

The hydra also appears to have interesting potentialities for the analysis of the toxic actions of certain drugs. Protoplasmic poisons such as strong cocaine solutions were quite destructive to the hydra. A series of amidines, which were known to produce necrosis in higher animals, actually disintegrated the hydra within a matter of minutes. On the other hand, drugs which exert their lethal actions in higher organisms by affecting such organizations as the respiratory center, were relatively harmless. For example, neither morphine nor the very toxic curare killed the hydra, even in high concentrations.

Book Reviews

Radioactive tracers in biology: an introduction to tracer methodology. Martin D. Kamen. New York: Academic Press, 1947. Pp. xiii + 281. (Illustrated.) $5.80.

Prof. Kamen has achieved to a remarkable degree his objectives in having *Radioactive tracers in biology* provide (1) an introduction or a review of those concepts in nuclear physics, an understanding of which is basic to the intelligent application of tracer methods in biology; (2) a presentation of a systematic and critical survey of existing tracer methods; and (3) an indication of potentialities and limitations of these methods as applied to biological problems. This small, but extremely fact-packed, guide should find a welcome place on the working bookshelves of biochemists, biophysicists, physiologists, and physicians who are interested in the application of radioactive tracers to studies in biology.

The first section, a review of nuclear physics, demands a greater amount of reader effort than do the sections relating to procedures in the production and assay of radioactive isotopes. The information about procedures for radioactive assay is given in precise detail.

For the biologist, Chapter V, "A Survey of Tracer Biology," is an extremely stimulating and informative presentation of biochemical and physical applications, including the study of intermediary metabolism and a well-presented discussion on analysis by isotope dilution methods. Under physiological applications, the author discusses permeability studies, metabolic turnover, and transport studies.

Chapters VI to X, inclusive, elaborate on the use of radioisotopes and include a thorough discussion of radioactive hydrogen (tritium)—and, incidentally, an extremely valuable table of deuterium compounds—as well as C^{11}, C^{14}, P^{32}, and S^{35}. The isotopes of secondary importance in biology are discussed in Chapters XI and XII, and the final chapter, entitled "Various Radioactive Isotopes of Importance in Biology," deals with such trace elements as manganese, iron, cobalt, copper, and zinc.

The biologist will find the study of this book of real value whether he plans to engage in utilizing radioactive isotopes or to broaden his understanding of this important technique.

The book is not without some weaknesses, stemming chiefly from an insufficient attention to radiation hazards. Although reference is made to National Bureau of Standards' Handbooks H-23 and HB-20, on "Radium Protection" and "X-Ray Protection," the reviewer believes that somewhat greater detail regarding the handling of hazards could have been incorporated in this volume. The author might also have elaborated his discussions of radiation effects in organisms and of the need for awareness of the ever-present hazards in research on metabolism with radioactive isotopes, because of the physiological effects of the radiation from the tracers.

This is apparently Volume I of a new series of monographs in Organic and Biological Chemistry under the editorship of Louis F. and Mary Fieser, to be published by the Academic Press. As such, one would hope for greater care in publication. An errata sheet listing 10 errors in a 270-page book does not speak highly of the diligence of proofreading. A certain amount of distraction, if not occasionally confusion, develops from the use of superscripts of the same type and point for designating the mass numbers and references to bibliographic footnotes.

The author has done the biologist a real service in offering this excellent work.

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Descriptive and sampling statistics. John Gray Peatman. New York: Harper, 1947. Pp. xviii + 577. (Illustrated.) $5.00.

This book recognizes the dilemma of social science students who need certain statistical knowledge and skill, but for whom the time requirement of mathematical training is either discouraging or prohibitive. In his attempt to meet the needs of this particular group, the author has made commendable use of ordinary English prose for the presentation of various statistical devices and the illustration of their uses. The text is entirely free from elaborate formulas and derivations. Its content is well supported by timely and appropriate illustrations, and excellent pedagogical value may be anticipated for the exercises at the conclusion of each chapter.

This very practical book will probably enjoy a wide demand as a text for undergraduate and first-year graduate students in education and sociology. It should provide a useful background for some kinds of research and will greatly facilitate the comprehension of those who must read the current literature in education, sociology, anthropology, and psychology.

Although the author has realized most of his expressed aims, his work is not without serious fault. The problem of nonlinear correlation receives a most summary dismissal; for example, Eta and Epsilon are ignored. The use of the important F test and the simplest illustrations of analysis of variance and covariance are omitted. A chapter on cluster and factor analysis is included, but the discussion is misleadingly inadequate. Neither the assumptions of factor analysis nor their implications are given. Spearman's two-factor theory receives one paragraph. All multiple-factor theories are lumped together in one paragraph. The rest of the chapter is concerned with a little-used, casual method of cluster analysis.

Despite the omission of certain important topics, the book has a broad scope and may create the illusion in the student that the treatment is comprehensive. This would be regrettable, because in general the assumptions underlying the development of the various statistics and governing their appropriate use are poorly defined or omitted. Equally serious is the presentation of a large group of standard-error formulas with the instruction that the statistics in question are essentially normally distributed. In the case of sample sizes commonly encountered, this assumption is questionable for some of the statistics, and for other statistics, e.g. the standard deviation, it is known to be incorrect. With few exceptions,

the student is encouraged to regard his samples as large samples. These limitations are not unique to this textbook, but they are regrettable in that they may encourage a "cookbook" approach to experimental design and the testing of statistical hypotheses.

The sequence of topics is unusual, and many things which ordinarily go together are widely separated and treated in a piecemeal fashion. Although there may be good reason for this, its merit was not apparent to this reviewer.

The simplicity and rigor of modern inferential statistics, particularly for small samples, may not be discerned by the student who uses this textbook, and he will have little opportunity to be discouraged by either the mathematical or logical rigor which features many textbooks in statistics.

Nevertheless, in terms of the aims of this textbook, its positive features greatly outweigh its shortcomings.

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Scientific Book Register

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